The Learning Styles of Monozygotic Twins: A Qualitative Study

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

John R. Mascazine, B.S., M.A.

***

The Ohio State University

1998

Dissertation Committee:

Dr. Patricia A. Brosnan, Co-Adviser
Dr. Barbara S. Thomson, Co-Adviser
Dr. Paul Vellom

Approved by

Patricia A. Brosnan
Co-Adviser

Dr. Barbara S. Thomson
Co-Adviser
College of Education
© Copyright by

John R. Mascazine

1998
ABSTRACT

The purpose of this study was to investigate the learning styles (LS) of monozygotic (identical) twins using in-depth interviews and the Dunn learning style model. Eight participants, four pairs of monozygotic (identical) twins, took part in this qualitative study. The participants were successful learners who had completed at least twelve years of formal schooling and were preparing for future professions in science related fields.

Participant interview responses, individual scores on the Dunn, Dunn, and Price LS inventory, grounded survey responses, and collected documents were analyzed. The data indicate that monozygotic twins have few of the elements of their individual learning style strengths in common. Their LS strengths often differ, even though they may have responded similarly to many of the interview questions. In learning situations, these individuals have their unique strong preferences when learning new or difficult information.

In addition to comparing specific elements of the Dunn LS model, five relevant themes emerged relating to the learning styles of monozygotic twins. These themes were: the importance of early positive learning experiences, the role of competition between the twins and their learning, the effects of twin recognition and their impact on learning, the desire and need for individual recognition and identity and its impact
on learning, and the awareness and use of individual learning styles by the twins in this study.

Specific quantitative comparisons were also made in this study. The learning style profiles of eighteen dizygotic (DZ) twin pairs and thirty-eight monozygotic (MZ) twin pairs were compared with regard to their LS strengths, intra-twin shared strengths, and discordant LS preferences. The results indicated that although MZ and DZ twins have similar average numbers of LS strengths as a group, MZ pairs have more LS strengths in common and fewer discordant preferences. However, both MZ and DZ twins did not share the majority of their LS strengths on the Dunn inventory.
This is dedicated to my loving parents, Carl and Irene, and to Mark Hanes — for their constant love, support, and encouragement.
ACKNOWLEDGMENTS

I owe a debt of special thanks to the following individuals who have helped me accomplish this dissertation research. First, I would like to thank my co-advisers and my committee: Barbara S. Thomson, Ph.D., Patricia Brosan, Ph.D. and Paul Vellom, Ph.D.. Special thanks to Mark D. Hanes for his support and help with \LaTeX. I would also like to acknowledge the support and encouragement of my peer researchers: Andrea Balas, Tamara Garcia-Barbosa, Wendy McCann, and Genie Maxwell. Special thanks also go to Bill Drapcho for his valuable insights, to Randy Fisher and Tomme Messer for their continuous support and encouragement, and to Zak and Bucky, for providing time to relax and reflect.
VITA

July 28, 1960 ........................................ Born - Mansfield, Ohio, USA

1982 ............................................................... B.S. Education, Ohio Dominican College, Columbus, Ohio

1983-1983 ....................................................... Seventh and Eighth Grade Teacher of Science, Reading, and Mathematics, Sacred Heart School, Coshocton, Ohio

1984-1987 ....................................................... Sixth, Seventh, and Eighth Grade Teacher of Science, Reading, and Mathematics, St. Mary School, Mansfield, Ohio

1987-1992 ....................................................... Sixth, Seventh, and Eighth Grade Teacher of Science, Social Studies, Reading, and Mathematics, St. Brendan School, Hilliard, Ohio

1992 ............................................................... M.A. Science Education, The Ohio State University

1992-1994 ....................................................... Sixth, Seventh, Eighth, Ninth Grade Teacher of Science and Mathematics, Columbus School for Girls, Columbus, Ohio

1994-present .................................................. Graduate Teaching Associate, The Ohio State University.

1994-present .................................................. Adjunct Faculty, Franklin University, Columbus, Ohio

1996-present .................................................. Adjunct Faculty, Ohio Dominican College, Columbus, Ohio
PUBLICATIONS

Research Publications


FIELDS OF STUDY

Major Field: Education
Specialization: Science Education

Studies in:

- Learning Styles
- Psychology-Cognitive Research
- Qualitative Research Methods
- Qualitative Research in Science Education
- Geologic Science-Field Geology
- Contextual Learning Experiences and Technology

Barbara S. Thomson, Ph.D.
Sarah T. Boysen, Ph.D.
Patricia Brosnan, Ph.D. and Patti Lather, Ph.D.
Paul Vellom, Ph. D.
Garry McKinzie, Ph. D.
Barbara S. Thomson, Ph. D.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Dedication</td>
<td>iv</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>v</td>
</tr>
<tr>
<td>Vita</td>
<td>vi</td>
</tr>
<tr>
<td>List of Figures</td>
<td>xiii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xiv</td>
</tr>
</tbody>
</table>

Chapters:

1. Some Issues and Concerns in Science Education              | 1    |
   1.1 Introduction                                            | 1    |
   1.2 National Issues in Education                            | 2    |
   1.3 What Learning Styles Offer                              | 3    |
   1.4 Why Study Twins?                                        | 6    |
   1.5 Combining Learning Styles and Twin Research              | 8    |
   1.6 Need for this Study                                     | 9    |
       1.6.1 Problem Statement and Questions                    | 9    |
       1.6.2 Rationale                                           | 10   |

2. Literature Review                                          | 11   |
   2.1 Introduction                                            | 11   |
   2.2 Review of Literature on Learning Styles                 | 11   |
   2.3 Learning Styles                                         | 12   |
2.3.1 Dunn Learning Styles and the Basis of Individual Learning Preferences ........................................ 13

2.4 The literature on twins and learning: Three Themes .................................................. 20
  2.4.1 Theme One: A Genetic Basis for Cognitive Ability? ........................................... 21
  2.4.2 Theme Two: The Interactionist Perspective or the Effects of Genetics and Experiences. ........................................ 27
  2.4.3 Theme Three: Developmental Changes in Twins ............................................. 31

2.5 Summary of Literature Review and Themes ......................................................... 32

3. Introduction to Research Methodology .................................................................. 35

3.1 Introduction ............................................................................................................. 35
3.2 Quantitative and Qualitative Aspects of this Study ............................................... 37
3.3 The Use of the Dunn Model for this Study ............................................................. 38
3.4 Methods and Procedures ...................................................................................... 40
  3.4.1 Population or Sample ...................................................................................... 41
  3.4.2 Measuring Instruments and Data Collection .................................................. 42
3.5 Pilot Study Results .................................................................................................. 44
  3.5.1 First Pilot Research Study .............................................................................. 44
  3.5.2 Second Pilot Research Study ......................................................................... 45
  3.5.3 Third Pilot Research Study ............................................................................. 46
3.6 Quantitative Data Analysis ..................................................................................... 47
3.7 Qualitative Data Analysis ....................................................................................... 47
3.8 Procedure and Implementation of Study ............................................................... 49
3.9 Use of Informant ...................................................................................................... 51
3.10 Research Strategy .................................................................................................. 51
3.11 The Case Study Approach .................................................................................... 52
3.12 Establishing Trustworthiness ............................................................................... 53
3.13 Description of the Researcher .............................................................................. 55
3.14 Summary of Research Methods ........................................................................... 55

4. Presentation and Analysis of Quantitative Data ....................................................... 57

4.1 Introduction ............................................................................................................. 57
4.2 Data Collection ....................................................................................................... 57
4.3 Quantitative LS Strength Comparison .................................................................... 58
4.4 LS Strength Comparison: Age as a Factor ............................................................ 60
  4.4.1 Graphical Comparisons of the Strengths of Identical Twins ......................... 60
4.5 Summary and Comments ....................................................................................... 64
5. Presentation of Qualitative Data ........................................ 65

5.1 Introduction ......................................................... 65
5.2 Carl and Jay ....................................................... 66
  5.2.1 Environmental Characteristics of Carl and Jay .......... 66
  5.2.2 Emotional Characteristics of Carl and Jay ............. 68
  5.2.3 Social Characteristics of Carl and Jay .................. 72
  5.2.4 Perceptual Modality Preferences of Carl ............... 75
  5.2.5 Perceptual Modality Preferences of Jay ................. 78
  5.2.6 Physiological Characteristics of Carl and Jay .......... 81
  5.2.7 Global Versus Analytical Characteristics of Carl and Jay 87

5.3 Ann and Jill ...................................................... 89
  5.3.1 Environmental Characteristics of Ann and Jill .......... 90
  5.3.2 Emotional Characteristics of Ann and Jill .............. 91
  5.3.3 Social Characteristics of Ann and Jill .................. 97
  5.3.4 Perceptual Modality Preferences of Ann ................ 100
  5.3.5 Perceptual Modality Preferences of Jill ................. 102
  5.3.6 Physiological Characteristics of Ann and Jill .......... 104
  5.3.7 Global Versus Analytic Characteristics of Ann and Jill 107

5.4 John and Jeff .................................................... 109
  5.4.1 Environmental Characteristics of John and Jeff ....... 109
  5.4.2 Emotional Characteristics of John and Jeff ............ 111
  5.4.3 Social Characteristics of John and Jeff ................. 114
  5.4.4 Perceptual Modality Preferences of John ................ 117
  5.4.5 Perceptual Modality Preferences of Jeff ................. 120
  5.4.6 Physiological Characteristics of John and Jeff ........ 124
  5.4.7 Global Versus Analytic Characteristics of John and Jeff 125

5.5 Mike and Dan ................................................... 128
  5.5.1 Environmental Characteristics of Mike and Dan ....... 128
  5.5.2 Emotional Characteristics of Mike and Dan ............. 130
  5.5.3 Social Characteristics of Mike and Dan ................. 135
  5.5.4 Perceptual Modality Preferences of Mike ............... 137
  5.5.5 Perceptual Modality Preferences of Dan ................. 138
  5.5.6 Physiological Characteristics of Mike and Dan ........ 141
  5.5.7 Global Versus Analytic Characteristics of Mike and Dan 143

5.6 Summary of Twin Learning Style Data ........................ 147

5.7 Concluding Remarks on the Qualitative Data ................. 147
6. Qualitative Analysis: Emergent Themes Across the Cases

6.1 Introduction

6.2 Emergent Themes from Interview Data

6.2.1 Theme One: Early Positive Learning Experiences in Science

6.2.2 Theme Two: The Role of Competition Among Twins and Their Learning

6.2.3 Theme Three: Twin Recognition and Its Impact on Learning

6.2.4 Theme Four: The Desire and Need for Individual Recognition and Identity

6.2.5 Theme Five: These Twins Who were Successful in School were Aware of Many of their Learning Style Strengths

6.3 Summary and Comments

7. Discussion and Future Research

7.1 Reflections on the Learning Styles of Twins

7.2 Revisiting the Research Questions

7.3 Implications of the Findings of this study

7.3.1 Implications for Teachers and School Administrators

7.3.2 Implications for Parents

7.3.3 Implications for Twins, Their Peers, and Their Siblings

7.4 Limitations of this Study

7.5 Summation Comments

7.6 Discussion of Future Research Questions

7.7 Reflections of the Researcher

Appendices:

A. Explanation of Dunn Learning Style Profile Elements

B. Source of Dunn Learning Style Inventory

C. Interview - Outline Questions

C.1 First Set of Interview Questions

C.2 Second Set of Interview Questions

C.3 Third Set of Interview Questions
D. List of Important Terms ................................................. 198

E. Global and Analytic Phrase List ................................. 202

F. Perceptual Modality Grounded Survey .......................... 204

References ................................................................. 206
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Carl and Jay’s LS Strengths</td>
<td>62</td>
</tr>
<tr>
<td>4.2</td>
<td>Ann and Jill’s LS Strengths</td>
<td>62</td>
</tr>
<tr>
<td>4.3</td>
<td>John and Jeff’s LS Strengths</td>
<td>63</td>
</tr>
<tr>
<td>4.4</td>
<td>Mike and Dan’s LS Strengths</td>
<td>63</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 The Dunn Stimuli and Learning Style Elements</td>
<td>15</td>
</tr>
<tr>
<td>2.2 Example of Typical Dunn, Dunn, &amp; Price Learning Style Profile</td>
<td>16</td>
</tr>
<tr>
<td>2.3 Data from the Minnesota Twin Study (1990)</td>
<td>24</td>
</tr>
<tr>
<td>3.1 Five Stimuli Categories (in bold print) with Specific Elements Investigated in this study</td>
<td>40</td>
</tr>
<tr>
<td>3.2 Elements of the Dunn LS Model and Their Global &amp; Analytic Corresponding Characteristics (Dunn, 1996b)</td>
<td>48</td>
</tr>
<tr>
<td>4.1 Comparison of LS Strengths</td>
<td>59</td>
</tr>
<tr>
<td>4.2 Comparison of the Shared Perceptual Modalities of MZ and DZ Twin Pairs</td>
<td>60</td>
</tr>
<tr>
<td>4.3 Comparison of LS Strengths, factoring in Age (7 pairs DZ, 7 pairs MZ)</td>
<td>61</td>
</tr>
<tr>
<td>5.1 Environmental LS Elements of Carl and Jay</td>
<td>67</td>
</tr>
<tr>
<td>5.2 Emotional LS Elements of Carl and Jay</td>
<td>73</td>
</tr>
<tr>
<td>5.3 Social LS Elements of Carl and Jay</td>
<td>75</td>
</tr>
<tr>
<td>5.4 Perceptual Modality LS Elements of Carl and Jay</td>
<td>82</td>
</tr>
<tr>
<td>5.5 Physiological LS Elements (other than Perceptual Modalities) of Carl and Jay</td>
<td>86</td>
</tr>
</tbody>
</table>
5.6 Psychological LS Elements of Carl and Jay ................. 89
5.7 Environmental LS Elements of Ann and Jill ............... 92
5.8 Emotional LS Elements of Ann and Jill .................... 97
5.9 Social LS Elements of Ann and Jill ....................... 100
5.10 Perceptual Modality LS Elements of Ann and Jill ........ 105
5.11 Physiological LS Elements (other than Perceptual Modalities) of Ann and Jill .................................. 107
5.12 Psychological LS Elements of Ann and Jill ............... 108
5.13 Environmental LS Elements of John and Jeff ............. 112
5.14 Emotional LS Elements of John and Jeff ................. 114
5.15 Social LS Elements of John and Jeff .................... 118
5.16 Perceptual Modality LS Elements of John and Jeff ...... 124
5.17 Physiological LS Elements (other than Perceptual Modalities) of John and Jeff .................................. 126
5.18 Psychological LS Elements of John and Jeff ............... 128
5.19 Environmental LS Elements of Mike and Dan ............. 130
5.20 Emotional LS Elements of Mike and Dan ................. 135
5.21 Social LS Elements of Mike and Dan .................... 138
5.22 Perceptual Modality LS Elements of Mike and Dan ...... 141
5.23 Physiological LS Elements (other than Perceptual Modalities) of Mike and Dan .................................. 143
5.24 Psychological LS Elements of Mike and Dan ............... 147
5.25 Environmental Elements for All Twins ................. 148
5.26 Social Elements for All Twins ....................... 148
5.27 Emotional Elements for All Twins ................... 148
5.28 Perceptual Elements for All Twins .................. 149
5.29 Physiological Elements for All Twins ............... 149
5.30 Global / Analytic Elements for All Twins ......... 149
CHAPTER 1

SOME ISSUES AND CONCERNS IN SCIENCE EDUCATION

1.1 Introduction

This chapter provides the foundation for this study. It begins by looking at some national educational issues. The chapter then discusses the importance of learning styles research and twin research. The need for this study and the rationale are explained including the statement of specific research questions.

This chapter discusses the following items:

- The rationale for using learning styles (LS) and twin research studies for this research.

- The rationale and need for employing qualitative research methods for this study.

- The research questions which are listed in Section 1.6.1 and may be summarized as:

  1. What are the learning style strengths of monozygotic (identical) twin siblings and how do they compare?
2. What does qualitative data reveal about the learning styles of monozygotic twins?

3. Do monozygotic twins have similar learning styles as a group and when compared with dizygotic twins as a group?

1.2 National Issues in Education

Students in schools across the United States are lagging behind their peers in other industrialized nations according to recent comparisons on standardized tests (Educational Statistics, 1996; Educational Standards, 1992). This is especially noticeable when comparing the results of math and science subsections. Many educators and government leaders fear that this may be a trend and they advocate further reforms of our educational system, even while some efforts such as Project 2061, Benchmarks for Science Literacy, and National Science Education Standards have yet to be fully implemented.

Another concern is the decline in numbers of students pursuing academic study or careers in mathematics or sciences (Educational Standards, 1992). Coupled with this is data indicating that the sciences are continuing to be “unfriendly,” undesirable fields of study for females, African-Americans, Hispanics, and other groups within our system (Jones, Mullis, Raizen, Weiss, & Weston, 1992). Early experiences in math and science education do influence attitudes and interest in future study (Rutherford & Ahlgren, 1989; Jones et al., 1992). This lack of interest could result in future shortages in those conducting research (Rutherford & Ahlgren, 1989; National Research Council, 1996).
To further complicate the situation, teachers are finding it increasingly difficult to meet the demands of a changing and diverse student population (Educational Statistics, 1996). Many teachers are exiting the profession after only brief careers, finding the demands too high, the rewards too few. Math and science educators are in short supply (Educational Standards, 1992). In many schools these subjects must be taught by teachers with limited training or experience in methods or recent reform efforts. Thus, teachers with limited expertise may be further deterred in their work by increased demands for achievement in math and science, as well as, the demands of a diverse student population.

1.3 What Learning Styles Offer

Learning styles (LS) research can provide the background necessary for understanding students and the different ways individuals learn. Such research emphasizes greater attention to the ways individuals perceive and process information. Teachers can benefit from analyzing their own style and its implications for pedagogy. Learning style information can be useful as a metacognitive device, which helps teachers evaluate their own teaching strategies in terms of how they match student learning styles.

In several studies the implementation of teaching strategies in concert with individual LS characteristics has resulted in improved academic achievement, attitude toward learning, and increased self-confidence in learning situations (Dunn, Beaudry, & Klavas, 1989; Griggs, 1991; Griggs, Price, Kopel, & Swaine, 1984). Many studies have confirmed the usefulness of LS with students in primary grades through post-secondary education (Dunn & Dunn, 1993; Griggs, 1991; Lynch, 1981; MacMurren,
1985). The positive effect LS teaching strategies have upon educators has also been documented (Klavas, 1993; Kahre, 1985), including improved teacher attitudes and reductions in teacher burn-out.

The research indicates that attention to LS improves student motivation, as well as achievement. Students of various levels have been shown to benefit from the implementation of learning style approaches (McCarthy, 1987; Dunn & Dunn, 1993; Griggs, 1991; Lynch, 1981). Although there are many different LS models that may be used in educational settings, only one model seems appropriate for this study. The Dunn model was selected for use in this study because of its comprehensiveness and reliability as judged by Griggs (1991), DeBello (1990), Given (1996).

Research on learning styles (LS) has been conducted for years, although it has often been reduced to references to perceptual modalities by many educators. Most of the research and serious work on LS has been done in the 1970s with well-known contributors as the Dunn’s, Gregorc, Kolb, and others. The research has centered on students of various educational levels and intellectual abilities in a wide range of content areas. Gregorc’s and Kolb’s LS research has been concerned with the populations of adults and older students (Griggs, 1991). Their work also centers on the global and analytic psychological characteristics, not on other characteristics. There is limited research supporting their LS theories. However, Kenneth and Rita Dunn have amassed the greatest amount of research data, which they synthesized into a comprehensive theory that is the most complete in scope and research today. While many researchers have conducted studies to look at the learning styles of various cultural groups, age levels, and other socioeconomic data, little research has been conducted regarding twins and their particular learning styles. Differences in LS
have been discussed and confirmed by Given (1996), Griggs (1991), DeBello (1990) in other populations.

This study was needed to accumulate qualitative data regarding learning style elements and their development. Such details and specific information is necessary for teachers, parents, and individual learners if they are to comprehend and appreciate the diverse ways in which humans perceive and process information that is new or difficult. The availability of such information, beyond the accumulation of broad based numerical data, can contribute to the further implementation of learning style programs and the usefulness of learning styles to teachers.

By studying twins and their learning styles one was able to study the differences and similarities of two genetically similar individuals. This further illuminated specific influences and rich details of the development of learning styles. Studying identical twins reared in the same home environment has also served as a way of tracking common experiences and their impact on the development of one’s learning style.

If identical twins do indeed show similar learning styles or LS strengths, it may indicate the strength of genetic influences on how we prefer to learn. If identical twins do not share similar learning styles, it may mean that our learning styles develop and are influenced by factors other than those of the environment or by genetics, or perhaps a combination. Likewise, if genetically similar individuals do not share common learning preferences and approaches, we need to stress even more the need to teach to individual learning styles and learning preferences when possible. Furthermore, it would seem plausible that the earlier we can discover a student’s particular learning style, the earlier we can intervene and help them strategize to optimize their strengths. This study was instrumental in providing a foundation of qualitative data on learning
styles. Such attention to LS can empower learners to exercise more responsibility and control over their own learning.

The possibility of discovering some similarities and some differences between monozygotic (identical) twins and their learning styles was also considered. If this is the case, twins may be able to utilize these strengths and shared LS preferences when learning new or difficult information together. On other tasks and situations, they may not share strong similarities; and thus, should work according to each individual’s strengths. It is also possible that certain elements of a person’s learning style will be more similar to their sibling’s than other elements. If such a finding were substantiated by data, it could lead to a fuller understanding of which key elements future research may need to focus.

1.4 Why Study Twins?

Twin studies have been conducted for a variety of purposes: genetics research, personality research, environment-genetics research, medical research. However, a review of the literature exposed few, if any, studies dealing specifically with whether twins learn in a similar manner or, more specifically, if they have similar individual learning style strengths. No studies have specifically used or addressed the LS elements of the Dunn LS model with twins. This is noteworthy because some research studies have attempted to stress the importance of heredity over environmental influences on one’s personality or mannerisms (Bouchard, Lykken, McGue, Segal, & Tellegen, 1990). Other researchers have concluded that some elements of learning style are
more likely to be influenced by heredity than others, such as physiological and psychological elements (Restak, 1979, 1994; Theis, 1979). Identical twin LS studies could help illuminate some of these issues.

The advantage of studying identical twins in this study involves the opportunity to study genetically similar individuals with the same home life and rearing backgrounds while having the opportunity to compare and explore learning style elements. It was a unique opportunity to discover rich descriptive qualities of two individuals and experiences contributing to their learning. Studying how identical twins process information allowed us to control for some variables, such as genetic similarity and shared home life, while observing other variables, such as sociological preferences when learning.

Twin research involving learning styles holds the promise of determining the similarities and differences of how genetically similar individuals perceive and process information in new or difficult learning situations. Such research may substantiate the need for individualizing instruction for twins, even though they are often considered alike in many other ways. Distinct differences in the learning styles of twins could prompt some teachers to take seriously the need to recognize learning style differences in all students and to design appropriate teaching strategies. Since many teachers may not consider learning style issues important enough to address, this study provides further evidence that teachers, parents, and students can benefit from such information.
1.5 Combining Learning Styles and Twin Research

This study explored the learning styles of twins, especially monozygotic twins. It used in-depth interviewing, and either the Dunn, Dunn, & Price LS inventory or Dunn, Dunn, & Price Productivity Environmental Preference Survey (PEPS) inventory. The former inventory was designed for use with students in grades five through twelve and geared to their reading level. The latter inventory (PEPS) was developed for use with adults, who may or may not be students. Both have high reliability and validity (Griggs, 1991; Theis, 1979). The qualitative and quantitative methods and procedures for this study were constructed and/or modified with the help of three previously-conducted pilot studies.

The following characteristics made this study unique and useful in accumulating additional information on twins and their learning patterns. It was the first study to use the Dunn LS model purposefully with monozygotic and dizygotic twins. This was a study that examined LS using qualitative research methods, thus supplementing collected quantitative data. This study also demonstrated a need to conduct future studies of this kind to gather a greater depth of information on the topic of learning styles and twinship.

The research involving twins included personality and psychological studies to biological-physiological studies in the last century. It reached a peak with the work of Bouchard and Lykken in the 1980s. Their research centered on the psychological differences between twins, especially those reared in separate homes by adoptive families. Their research was popularized by the media and contributed to a culture of anecdotal evidence supporting the ideas that genetic components were considered
dominant and more influential than environmental conditions. And although interviewing was used as a method of data collection and for data clarification, many of the findings were based on quantitative data of a large number of monozygotic and dizygotic twins.

1.6 Need for this Study

1.6.1 Problem Statement and Questions

The research on learning styles and its impact on achievement is quite impressive. However, many educators still question the quality and ease at which such quantitative results can be applied or used by individuals. This study investigated the learning style elements and patterns of identical twins employing the Dunn model as a framework. The following areas were investigated and compared in this research study:

- The learning style strengths of monozygotic (identical) twins
- The qualitative information on learning styles and its significance to understanding aspects of learning style
- A comparison of the learning styles of monozygotic twins as a group and with each other

These research areas may be summarized in the research questions that follow. These questions guided the researcher.

- What are the learning style strengths of monozygotic twin siblings and how do they compare with each other?
• What do the quantitative and qualitative data reveal about the learning styles of monozygotic twins?

• Do monozygotic twins have similar learning styles as a group and when compared as a set of twins with dizygotic twins?

The answers to these questions contributed to a more complete understanding of the specifics of how MZ twins learn.

1.6.2 Rationale

One of the key ideas behind the emphasis and research on learning styles is that of establishing an understanding of the diverse ways in which individual learners perceive, process, and work with new or difficult information. Proponents of learning style research realize the importance of recognizing and honoring each person’s individual approach to learning. Moreover, many stress the value of matching individual strengths and learning preferences to instructional or study practices. Dunn, McCarthy, Gregorc, and others have substantiated claims that attention to one’s individual LS can contribute to improved success at learning tasks, an improved attitude toward learning, and improved self-confidence.

Realizing the inherent differences among learners and how they approach learning tasks, many teachers continue to teach using a limited range of strategies or styles. Teachers and parents need to better understand the differences that exist among students. One of the goals of this study was to explore the nature of learning styles among monozygotic (identical) twins with the goal of gathering data which can be used to help parents and teachers become aware of similarities or differences among this segment of the population.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explains some of the research involving learning styles and twins. Section 2.3.1 begins to explain the Dunn LS model and its relevance to education. Section 2.4 reviews some relevant research involving twin studies and the significance to understanding their cognitive ability. The research on twins is divided into three themes: the genetic basis for cognitive ability, the interactionist perspective of genetics and experience, and the developmental changes in twins. A summary of the literature is provided in Section 2.5

2.2 Review of Literature on Learning Styles

The literature on learning styles is comprehensive and spans over thirty years of research. Among the most comprehensively studied and tested of all learning style theories and models is the one developed by Dunn, Dunn, and Price (1977), more commonly referred to as the Dunn, Dunn, and Price Learning Style Inventory (LSI), or simply the Dunn LSI. Kenneth and Rita Dunn of St. John’s University in New York have conducted the most extensive research studies on various aspects of learning
with people of all ages, ability levels, and socio-cultural groups. Much of their work has been critically analyzed by practicing teachers, university researchers (at other institutions), and by others in public and private institutions. What follows are some of the most important resources and research findings pertinent to this research study.

A second section of research literature that is relevant to this dissertation project is that involving twins, specifically monozygotic (identical) twins. Again, the research on twins generally involves psychological or medical information collected for on-going genetic and pedigree information.

Both bodies of research literature are composed of mainly quantitative studies that incorporate information obtained from surveys and statistical analysis. While some use of interviewing and qualitative methods had been employed, rarely have such methods been employed as primary or comprehensive ways of collecting data, especially in obtaining information on the unique educational issues relating to twins.

The research literature involving both twins and how they learn is even more limited. Few studies have been identified that link these two areas. Furthermore, no studies have been located that research identical twins and the use of the Dunn LSI using qualitative methods. Many studies have employed problem solving tasks or IQ instruments but not with the intent of studying individual learning styles or LS strengths.

2.3 Learning Styles

The definition of what constitutes learning styles needs clarification. The most accepted definition is: unique ways individual learners perceive and process information. The Dunn model defines learning styles as perceptual and processing characteristics
of individuals when attempting to learn new or difficult information (Dunn, 1996a). While some learning style advocates have emphasized changing pedagogy or curricula to help students flex and cope with unfavorable learning environments, such as in the McCarthy model, the Dunn model is among those that advocate understanding learner differences first, and then creating and using methods and materials that appropriately match the learner’s LS. One of the strengths of the Dunn model is the availability of teacher tested curricular materials designed to appropriately address many of the specific LS elements. Such materials may be initially developed by teachers for students, then later be created by students themselves. These include Programmed Learning Sequence Packages (PLS), Contract Activity Packages (CAP), Task Cards, Electroboards, among others. Many of these are discussed further by Dunn and Dunn in *Teaching Secondary Students Through Their Individual Learning Styles: Practical Approaches for Grades 7-12*.

### 2.3.1 Dunn Learning Styles and the Basis of Individual Learning Preferences

There is substantial evidence supporting the use of learning styles in all levels of classroom instruction as cited by Griggs (1991) and Given (1996). Much of the research on LS is also validated by biological research on the differences in cognitive and neurological function. Stronck (1980), Restak (1979, 1994, 1995), and Shepherd (1994) cite evidence of anatomical, cognitive, and physiological differences that exist among humans that can influence learning. Stronck (1980) makes a strong case for educators to acknowledge biological differences and for the individualizing of instruction. Ornstein (1993) and Sylwester (1995) elaborate upon the physiological and neurological differences often overlooked among students. Ornstein goes so far as to
say that our cerebral cortices are as different and as unique as our faces. Sylwester also encourages educators to understand some of the latest research on the brain and on its development, and then to implement pedagogical strategies that are matched with what we understand about brain function. His book, *A Celebration of Neurons*, does a superb job of explaining some of the implications brain research has upon our understanding of how students learn and how teachers teach.

Caine and Caine (1991) in their book, *Making Connections: Teaching and the Human Brain* offered a rationale for individualizing instruction for students based upon research on the development and function of the human brain. They cite the renowned work of Marian Diamond, among others, and the role certain areas of the brain, such as the limbic system, have upon one's ability to learn. Human learning is biologically varied and includes emotional and social constraints. For example, one's ability to adapt to new situations and master new skills is often contingent upon the presence of others and the emotional state of those present. Diamond’s research with rats and with the human brain has highlighted some of these issues.

Shepherd (1994) explains how neural developmental differences and early environmental experiences can contribute to individual learning preferences. Developmental differences are evident in prenatal, as well as postnatal development, and may include hormonal and nutritional influences upon brain development. Shepherd explains how neuronal migration occurs from deeper basal regions of the human brain and how these may influence cognitive processes. Some such migrations and neuron development continue into early adulthood and influence one's ability to successfully solve abstract problems (Shepherd, 1994; Sylwester, 1995). For example, high school and college students sometimes have great difficulty learning abstract concepts such as
<table>
<thead>
<tr>
<th>Five Stimuli</th>
<th>Elements within the Stimuli*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional</td>
<td>motivation, responsibility, persistence, structure</td>
</tr>
<tr>
<td>Environmental</td>
<td>light, sound, design, temperature</td>
</tr>
<tr>
<td>Sociological</td>
<td>peers, pairs, group, self, adult, varied</td>
</tr>
<tr>
<td>Psychological</td>
<td>global, analytic, hemisphericity</td>
</tr>
<tr>
<td>Physiological</td>
<td>time of day, intake, mobility, perceptual modality</td>
</tr>
</tbody>
</table>

*These are further explained in Appendix A.

Table 2.1: The Dunn Stimuli and Learning Style Elements

those encountered in an advanced physics or calculus course if taught before their prefrontal lobes are fully developed. New research on this is questioning the way schools plan the scope and sequence of the curriculum.

The Dunn LS model consists of the categories and specific elements shown in Table 2.1. They are further explained in Appendix A. One’s learning style typically reveals strengths in as few as three or four specific elements to as many as fifteen. Attention to these individual elements, or LS strengths can make the greatest difference in one’s ability to concentrate and work on new or difficult information when learning. The model was developed by the Dunns over a period of more than thirty years of research and testing (Dunn & Dunn, 1973, 1993; Dunn, 1996b).

Quantitative results following the administration of the Dunn, Dunn, and Price LS inventory are commonly shown as a graphic display similar to the one in Table 2.2. Numerical scores are distributed along a continuum which characterizes one’s individual preferences. Extreme scores, which indicate strong preferences, are the ones most likely to influence one’s learning. Extreme scores are those forty (40) or below and those sixty (60) or above on the Dunn LS profile. Primary and secondary
Table 2.2: Example of Typical Dunn, Dunn, & Price Learning Style Profile showing the scores for various LS elements plotted on a horizontal scale from 20 to 80, with 40-60 representing less important elements, while elements between 20-40 or 60-80 are considered strengths and important preferences.

Perceptual strengths may also be identified and given attention when one is learning new information and then trying to reinforce such information. The Dunn model has been used by many researchers to produce extensive materials and publish research demonstrating how such profiles can be useful in matching learning preferences and teaching strategies.
Beyond citing the biological research that supports the differences among how learners approach and accomplish learning tasks, there is educational research supporting the effective use of learning style techniques with students. This research spans academic levels and content areas, as well as different student characteristics. Stone (1992) explained the results of one elementary school that implemented changes from discovering and applying the Dunn model over a period of four academic years. This particular North Carolina school was initially beset with academic, discipline, motivation, and attendance problems (i.e., high level of teacher burn-out). Upon institution of the Dunn model with its accompanying teacher-created learning materials (such as task cards, educational kinesthetic floor games, flip chutes, and others), discipline problems within the school decreased from over one hundred per year to less than twenty per year. Standardized scores went from being in the 30th percentile to the 80th to 90th percentile in four academic years. Teacher and student attitudes and enthusiasm increased too. This school that was once considered to be among the worst in the system became known as one of the best in terms of academic achievement, motivation, and attendance.

Another such school was described by Klavas (1993). The teachers and the principal began using the Dunn LS model in designing classroom environments, restructuring schedules to meet students’ time of day preferences, varying and matching methods and perceptual strengths of students. The results were phenomenal. Student standardized scores, attitudes, and self-discipline improved greatly. Even students considered slow or learning disabled realized academic gains. Many of these students were mainstreamed into regular classes and were no longer considered to be “slow learners.”
Brunner and Majewski (1990) likewise, found astonishing results upon using the Dunn model with handicapped students in a New York school that was notorious for low standardized test scores on the New York competency exams. Students from this school regularly scored in the 20th to 30th percentiles. After using the LS strategies with handicapped students, the percentiles rose to the 80th percentile. Many students were mainstreamed into regular classes after attention was given to elements of their individual learning styles. Other schools within this district began using the Dunn model following these results.

Pennell (1985) makes a point of letting individual students know, accept, and adapt to their individual strengths and preferences for learning. His research complements that conducted by Dunn (1993, 1995, 1996a) and Lyons and Languis (1985). These support the idea that discovering and using one’s personal LS strengths leads to improved attitudes, attention, and confidence; which generally results in improved academic performance.

Dunn, Griggs, Olson, Gorman, and Beasley (1995) did a comprehensive study involving two years of meta-analysis of LS models and the Dunn model in particular. The analysis indicated that the Dunn model was the most successful and comprehensive, demonstrating improvements of an average 3/4ths standard deviation in academic scores for most students. Forty-two colleges and universities have also researched the usefulness of the Dunn model and their results agreed with those of Kirby (1979) and Given (1996), both of which gave the Dunn model very high marks on reliability and validity.

Dunn, Bruno, Sklar, Zenhäusern, and Beaudry (1990) used the Dunn model, especially the psychological elements of global / analytic processing characteristics with
minority college students enrolled in a mathematics course. Results indicated improvement in both academic scores and student attitudes toward mathematics. Students who were strongly analytic or global demonstrated improvement when taught using their preferred analytic or global strategies. Global students showed the greatest significant improvement. Math is one subject that is often taught analytically and global students’ scores and attitudes improved most dramatically when their needs were addressed with appropriate methods of instruction. Some global strategies included beginning class with an application-based story relating to the content in a lesson or lecture, connecting content to student experiences, and employing collegial work arrangements and assignments.

Cutter (1994) and McCarthy (1987) also found distinct differences among individuals in school and social settings, especially when considering global and analytic characteristics. Cutter’s work in counseling, using hemispheric differences and global/analytic characteristics, documents many differences in how global and analytic persons communicate and problem-solve. McCarthy distinguished between right and left brain hemispheric strengths and approaches and their impact on one’s learning. Such attention to global/analytic or right/left hemisphere differences in instruction and counseling have been shown to contribute to improved attitudes toward learning, as well as increases in academic achievement.

Researchers using the Dunn LS model have developed teaching strategies that closely match student learning styles. For example, analytic students who like working alone can be given opportunities to complete assignments by themselves and they may often require quiet and formal environments to do so. Global students often demonstrate a need to be taught collegially, with relevant stories that bridge content
with experiences. They often prefer to be given choices on assignments. As another example, perceptual strengths can be accommodated by using instructional methods that are not overly dependent upon only one perceptual ability. Lectures are very auditory experiences. Non-auditory students who attend them may need visual or tactual ways of recording or processing the information. Kinesthetic learners may require opportunities to reinforce lecture material by movement, even if only when reviewing material at home or apart from the traditional school experience. They can also benefit from movement experiences by being part of the lecture or by being included in demonstrations. Such learners may also require frequent breaks that allow for movement prior to continuing the lecture. These and other teaching strategies are further discussed in books and articles by Rita Dunn and her collaborative researchers. These teaching methods are discussed in much of the published work on the Dunn LS model.

2.4 The literature on twins and learning: Three Themes

The literature on twin research can be appropriately divided into themes or areas. Among the most prevalent is that of the role of genetics upon the behavior and cognitive ability in twins. The discussion of the role of heredity often is counterbalanced with research citing evidence for the influence of environmental factors. So, three themes that are pertinent to discuss in any review of the literature on twin research are: (1) the role or impact of genetics, (2) the combination of heredity and environmental impacts and, (3) how some twin research studies have shown that cognitive abilities and their development changes over time. This third theme has emerged most
recently and has helped researchers comprehend and identify some such changes over
time, thus influencing the degree to which one may generalize research findings.

2.4.1 Theme One: A Genetic Basis for Cognitive Ability?

Any consideration of the research on twins often produces discussions of the
nature-nurture controversy that for many current researchers is moot. Sylwester
(1995), among others, states that determining the greater influence of either nature
(genetic influences) or nurture (environmental influences) is analogous to trying to
determine which hand produces more sound when one is giving applause. Gordon
and Lemons (1997) further elaborated on this by making the case for an interactionist
perspective. Such an understanding would take into account such variables as social
and cultural influences, as well as experiences that are the collective result of the
interaction of genetic and environmental influences. Many biologists and psycholo-
gists no longer seek to determine the quantifiable influence of either, since both are
thought to be operating simultaneously (Pinel, 1993). Sylwester (1995) makes the
point that neither exists without the other.

Other considerations for the debate between these two elements are that of vari-
ability. Each organism’s development is varied and complete with certain critical
periods, whereby environmental or genetic influences may have greater impact upon
the organism (Shepherd, 1994; Pinel, 1993). Even during such periods there are
exceptions that are still being interpreted by researchers. For example, exceptions
occur within developmental periods, such as the development of language or abstract
thought. At one time these were thought to be limited to specific chronological periods in human development. However, current research suggests that there is greater variability.

Twin studies often focus on the importance of genetics because the occurrence of twins is relatively rare in the human population and twins appear to share many similar traits and behaviors. Some studies even go so far as to allocate a certain percentage of influence due to genetic or environmental factors. Bouchard et al. (1990) makes the case for IQ variability among monozygotic twins accounting for as much as 70% influenced by genetic factors. Yet, studies have also documented that, contrary to expectations, as similar individuals age there tends to be greater similarity considering genetic factors rather than less. One would expect the influence of nurturing experiences to become greater as one ages, not less. Bouchard admits that his findings do not preclude the effect of education or experience upon IQ or cognitive development.

Bouchard’s Minnesota Twin study, as it is often called, examined 56 pairs of monozygotic twins reared apart and 458 pairs of twins reared together. Bouchard et al. (1990) sought to determine the effect of rearing on intelligence and personality characteristics. Twins underwent fifty hours of testing and interviews at the University of Minnesota with a team of researchers. Researchers concluded that monozygotic (MZ) twins were similar in personality and intelligence whether reared together or apart. Correlations for MZ twins reared apart for IQ was approximately 0.70, while for twins reared together the correlation was approximately 0.85 which were shown to be significant. For personality, twins reared apart and twins reared together both had correlations approximately 0.50 (Bouchard et al., 1990). These results match
others reported by Plomin (1990) and Scarr and Kidd (1983). However, Bouchard warned that since many of the twins in his study were reared in similar industrialized countries and those adopted twins and their adopted families had similar requirements, care should be taken in interpreting these results and generalizing to all sets of monozygotic twins whether reared apart or together. One statement from this study that did raise the eyebrows of many researchers was that of attributing 70% of the variance of IQ of monozygotic twins to genetic variation.

The Minnesota Twin study was popularized by the press which interpreted the findings to mean intelligence and personality were dependent more upon one’s genetics than one’s environment. This notion perpetuated many myths regarding twins and the purpose of such studies (Pinel, 1993). And while Bouchard did not intend to undermine the important role experience or the environment has in the development of one’s intelligence or personality, some of the findings of his study were viewed in that way.

Looking at some of the Minnesota Twin study results in Table 2.3, one may see some of the correlations and the tests used to assess various aspects of intelligence and personality. Note that there is a greater correlation value for twins reared together in each of the tests, and the IQ correlations show greater disparity than the biophysiological brain wave data for twins reared apart. The Minnesota Twin study examined many elements that contribute to mental ability and problem solving, however; the study was not designed to examine the particulars of twin learning styles. There was no specific data reported from this study that specifically addressed the learning styles of twins.
<table>
<thead>
<tr>
<th>Electroencephalographic (brainwave) amount of 8-20 Hz (alpha) activity</th>
<th>Twins Reared Apart</th>
<th>Twins Reared Together</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-frequency (alpha) activity</td>
<td>0.80</td>
<td>0.81</td>
</tr>
<tr>
<td>Information Processing Ability Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed of Response</td>
<td>0.56</td>
<td>0.73</td>
</tr>
<tr>
<td>Mental Ability (General)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAIS IQ (full scale)</td>
<td>0.69</td>
<td>0.88</td>
</tr>
<tr>
<td>WAIS IQ (Verbal)</td>
<td>0.64</td>
<td>0.88</td>
</tr>
<tr>
<td>WAIS IQ (Performance)</td>
<td>0.71</td>
<td>0.79</td>
</tr>
</tbody>
</table>

*These are only selected results chosen for reference here because they relate indirectly to the LS-Twin study.

Table 2.3: Data from the Minnesota Twin Study (1990)

In addition to the numerical data collected by Bouchard and his colleagues, volumes of anecdotal information were collected and analyzed. Such data resulted in many unique and amazing stories told by twins demonstrating instances of great similarity. These too were often selected as topics in the popular media. Many of these stories gave inaccurate interpretations that identical twins were similar in most every way due to their genetic similarity.

One other finding that was often overlooked was that of heritability of cognitive ability increasing with age. As the twins age, there appears to be increased similarity in how they perform on cognitive measures (Bouchard et al., 1990). This appears to contradict what one would expect. The Minnesota Twin study researchers indicated that increased similarity between twins leads to increased contact among them even as they age, thus contributing to similar cognitive function.
In another study, sets of monozygotic and dizygotic twins aged 80 years or older were studied. This study also included an analysis of twin studies that included more than 10,000 pairs of twins and estimated that approximately half of the variance of general cognitive ability scores is due to genetic differences (McClearn et al., 1997). This is substantially less than the estimate given for IQ in the Minnesota Twin study. Such a discrepancy may be the result of yet unexplored factors.

Other studies were conducted that appeared to support the findings of Bouchard and the Minnesota Twin study. Segal (1985) conducted a study of monozygotic (MZ) and dizygotic (DZ) twins aged 5-13 years old and found IQ correlations to be 0.85 for MZ twins, 0.45 for DZ twins. However, in this same study, the correlation demonstrated by MZ twins on some of the subtests were only 0.45, which is not a strong correlation. Segal (1984) also studied such qualities as cooperativeness, competition, and altruism in MZ and DZ twins. Findings from that study confirmed the expected outcome that MZ twins were more cooperative than DZ twins when working together in problem solving situations. DZ twins were observed to be more independent in such tasks. Segal’s findings, while contributing to our understanding of the relationship of twins in problem solving tasks, is not to be taken as evidence of the role of genetics alone.

Wilson (1983) completed a study of 494 pairs of twins from infancy to fifteen years. Results were again interpreted to support the role of genetics in the cognitive development of MZ twins. Again, contrary to what one would expect, the MZ twins showed increasing concordance with aging, not less. Their cognitive developmental trends were more concordant than those of DZ twins, which some consider to be evidence for the role of genetics in determining the rate of cognitive development. In
another study, Wilson (1986) drew attention to the cognitive profiles of MZ twins from childhood to adulthood, citing additional data that age makes a difference when exploring similarities or differences among the cognitive profiles of twins.

The genetic argument and its impact on an individual’s cognitive ability was reflected in studies involving Attention Deficit Disorder (ADD) as well. Heffron, Martin, and Walsh (1984) found that three pairs of MZ males ages 6.5, 7, and 8 years were concordant for ADD. The study also reviewed other studies that gave credence to the role genetics may have in this learning issue. The researchers also emphasized the role other factors may have as well. Such factors cited included: prematurity, abuse, and neglect, which could be classified as environmental or nurturing factors.

Finally, there are many studies that cite the physiological similarities among twins, especially monozygotic twins. Clark et al. (1988) studied seven pairs of MZ twins and how their brains utilize glucose during problem solving tasks. Positron Emission Tomography (PET) scans were employed to view specific regions of the cortex while MZ twins were engaged in specific cognitive tasks. Results demonstrated that MZ twin’s brains utilized glucose similarly, especially in regions contributing to attention and posturing (motor) movement. The brains of MZ twins appear to function similarly in how they utilize glucose according to PET scan comparisons.

Lykken, Tellegen, and Iacono (1982) found other similarities in the brains of MZ twins. They analyzed Electroencephalogram (EEG) data, the brain wave data, of 50 pairs of MZ twins and 26 pairs of DZ twins ages 19 to 55. The EEG revealed a greater within pair similarity among MZ twins, while DZ twins were no more similar (in EEG data) than unrelated persons. The midfrequency of the alpha rhythm was strongly correlated in MZ pairs.
Monozygotic twins and DZ twins also show significant differences in their heart rates during psychological challenges. Turner, Carroll, Sims, and Hewitt (1986) conducted research monitoring the heart rates of twenty-two pairs of MZ male twins and twenty-nine pairs of DZ male twins. Heart rate responses while using a video game and completing a mental arithmetic task were monitored and analyzed. MZ twins showed much higher concordance than DZ twins when heart rates were compared. The test was repeated one year later using ten DZ and ten MZ twin pairs to determine if the heart rate concordance would still exist. The MZ twins demonstrated concordant heart rates, and their heart rates were consistent with data collected during the previous year’s trials.

The preceding studies and their explanations were important to this study concerning twins and their learning styles because they exhibit evidence that genetics is influential in cognitive processes, physiological functions, and cognitive development. However, other considerations must be explored and understood more fully before we make broad conclusions. Thus there is a need for research studies that will investigate specifically how twins process new and difficult information.

2.4.2 Theme Two: The Interactionist Perspective or the Effects of Genetics and Experiences.

A second prominent theme in twin research is referred to as “interactionist,” whereby the influences of genes and experiences of one’s environment are not separated, but considered as ever present and continuously interacting and contributing to one’s behavior and cognitive ability. They are thought to be operating simultaneously. Such an approach discards that notion of accounting for IQ or any other specific trait as the result of a certain percentage of genetic or environmental influences.
Gordon and Lemos (1997) advocate such an approach and caution against making blanket statements which assume a greater role to either heredity or environmental conditions. Three main points are emphasized in their research. First, behavior is the result of both social and biological origins and influences, and neither exists without the other among living organisms. Second, the interactions between biological and social factors produce complex behaviors that are multifaceted, not singularly produced. And third, the interactions result in bi-directional transformations, meaning that the directions of influence and the end results are not always predictable, or occurring in only one direction.

Bronfenbrenner (1991) points out that social outcomes and experiences are dependent on both genes and the environment, which may be uncharacteristic of some traits that are produced by genes. As such, social interactions change over time. Neither one’s genes, nor the environment are ever in total control in determining outcomes or effects. Caspi (1991) advocates the investigation of both environmental and social influences that effect learning because these account for individual variability and different educational outcomes. Such an emphasis would support learning style theories and the ideas espoused by the Dunn LS model.

Even Lykken (1982), a collaborator with Bouchard in the Minnesota Twin study, reports that there’s evidence for an “emergenic” relationship in determining behavior. His term relates to the interaction of several genes that together influence one’s traits or behaviors. Concordant emergenic relationships in twin behavior and personality have been documented in twins reared together and those reared apart according to Lykken. This implies that some of the behavior or traits of twins attributed to heredity may in fact be due to the combined effects of interaction of several genes.
Other researchers have begun examining the relationship of twins and how they are treated by others, especially their peers, siblings, and parents. One such study by Kozlak (1978) documented how twins are often viewed as a “unit” rather than as individuals. Kozlak’s work highlights the unique social or environmental factors that may influence behavior in and among twins, especially in learning situations. Kozlak has reported that while most twins consider themselves to be physically separate from their sibling twin, forty percent reported that they never felt that they had achieved an emotional separation.

Cassill (1982) advises caution in using information on one twin’s personality or genetic characteristics to predict the other twin’s personality or behavior, especially in learning situations. Although MZ twins may be very similar in many respects, their learning and school experiences may be very different. Guild (1997) emphasizes the diverse ways all students approach learning. In a comparison of brain-based education, Gardner’s theory of multiple intelligence, and learning styles, Guild de-emphasizes IQ or single measures of academic achievement. What is emphasized in each of these theoretical approaches to education is an understanding of the learner and their individual learning processes, as well as, their part in being a reflective practitioner who assumes greater responsibility for their learning whenever possible.

Sylwester (1995) too, would emphasize the value in understanding how the human brain functions in learning situations and how there are substantial differences among individual learners. He advocates support for the idea that learning and behavior results from complex interactions of one’s heredity and their experiences in the environment. In educational settings, he stresses the need for educators to be aware of the ongoing influences of each, both of which are continuously operating.
Sylwester also gives a rationale why all educators should have at least a rudimentary understanding of the human brain and its functioning in order to better understand the process of learning and pedagogy. Such an understanding would enable teachers to understand the physiological and cognitive differences among learners, and as such, may encourage them to implement a variety of teaching strategies and methodologies.

In another study conducted by Devlin, Daniels, and Roeder (1997), a flaw in many research designs was exposed. While some researchers have considered adopted twins as having “unshared” environments, other researchers have suggested that little attention has been given to the uterine environment shared by twins for nine months. Again the controversy stems from attempts to delineate between the environment and heredity. Recently this team of researchers from the University of Pittsburgh has discussed the implications of such a shared environment and the effects of maternal care upon cognitive development. Their findings suggest that the shared uterine environment may account for as much as 20% of the IQ similarities between twins and 5% of the similarities between other siblings. Of course, once again the argument is becoming one of percent of influence, which is perhaps a moot discussion. However, their findings do bring to the forefront a discussion of the over-emphasis of genetics in twin studies, and the under-valuing of maternal care and shared uterine environment in many twin studies (Devlin et al., 1997).

It is worth reporting that the studies evaluated and reviewed by the Pittsburgh team, a total of 212 studies, centered on personality and IQ among twins, and not on the ways in which they acquire or process information (i.e., learning styles). Some researchers advocate a greater exploration of the specific elements and interactions regarding cognitive processes (Scar, 1997; McClearn et al., 1997).
This second theme regarding the interaction of genetic and environmental factors appears to be a clear and reasonable idea. Why then has it taken so long for educational researchers to accept it as such? Part of the reason lay in its ambiguity. Many educational researchers, and many researchers involved in studying twins, have sought clear distinctions that may be identified and quantified. As many of the researchers previously noted, it becomes nearly impossible to distinguish between the influences of either heredity or environment when indeed both operate continuously and can interact with each other to produce additional influences. To some researchers, we are only now beginning to realize the complete relationship of such influences between twins.

2.4.3 Theme Three: Developmental Changes in Twins

A third common theme that emerges from twin research is that of evidence for changes in cognitive processes as one develops and ages. This is important because many studies have been done with twins as young as three months or as old as 80+ years. The findings, data, and conclusions of such studies must then be carefully considered to avoid over generalizing to twins of all ages and stages of development.

The greatest changes in cognitive development of twins appears to occur in the academic experiences and the transitional years of elementary to secondary school (Thompson, Detterman, & Plomin, 1991). This would tend to support the current study’s selection of participants beyond that developmental period. Wilson (1979) observed changes in 374 pairs of twins (MZ and DZ) over a period of three months through six years, and found that MZ twin pairs become increasingly concordant as they aged.
paralleling developmental spurts and lags. DZ twins became less concordant over this same time period.

McClearn et al. (1997) studied pairs of MZ twins 80+ years of age and discovered that MZ twins became more concordant at specific cognitive tasks even as they age into their eighties. It is also important to point out that the authors of this study advocate a greater research emphasis on specific cognitive traits of twins instead of research on general cognitive abilities. Reporting on the specific elements of learning styles of twins yields specific indicators contributing to cognitive processes.

This theme of developmental differences and changes among twins is receiving greater attention by researchers. However, many future studies will be needed to further clarify the specific cognitive differences and similarities as twins develop and age. Implications for this LS-Twin study include the selection of twin participants who are beyond the period of greatest change, the elementary to secondary school years. Participants were selected for interviews who were at least eighteen years of age and had completed at least twelve years of formal education.

2.5 Summary of Literature Review and Themes

A review of the literature on both learning styles and twins reveals many themes. Many of these themes have emerged from quantitative research studies, many have not been able to provide specifics on the learning styles of twins, identical or fraternal. Previous studies have also not been helpful to parents and educators in providing direction and advice on the differences between twin siblings and among samples of twins.
The research on twins has provided much data that has indicated ways in which twins, especially monozygotic twins, are alike. Often such data has been used to substantiate arguments as the origins of similarities and differences between sibling twins. Some twin research studies have focused on the influence of genetics or one’s environment, or the interaction that both may have upon twin cognition or behavior. Such studies, while useful in their own ways, do not provide many practical or specific recommendations on how twins process new and difficult information in learning situations.

A review of the literature on learning styles and twin research reveals very little qualitative data. Many of the studies have discussed this among their conclusions and recommendations for future research. It was also noteworthy that many of the quantitative studies have been subject to criticism for not providing detailed information relating to individuals, i.e. vignettes of rich detail. The addition of such qualitative information could lead others to consider the impact of the research on both learning styles and twins. Both sources of literature can contribute to our understanding of how individuals perceive and process information in both formal and informal settings, more so with the addition of the rich description of qualitative data that may be more practical to the teachers and parents of twins.

Summarized another way, the following has been noted from a review of the research on learning styles and twin cognitive ability:

- There is a lack of qualitative research data documenting learning style characteristics regarding twins.

- Previous studies on learning styles have not focused on specific case study literature but on statistical data.
• Many quantitative twin studies have emphasized the similarity of monozygotic twin siblings.

• Some twin research studies have focused on the nature (genetics) or nurture (environmental or experiential) or interactionist issues of twin variance, especially comparing IQ.

• Much of the twin research has not been helpful in addressing specific issues of how twins learn or process new or difficult information.
CHAPTER 3

INTRODUCTION TO RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research methods and analysis procedures for this study involving the use of the Dunn learning style model and interviews with monozygotic (identical) twins. The use of the Dunn model and its contribution to this current study are discussed. The following sections give details on how data was analyzed and sorted, as well as considerations such as pilot study results, use of an informant, and establishing trustworthiness.

This chapter contains the following topical areas relating to how this study was conducted (A summary of these methods can be found in Section 3.14 at the end of this chapter):

- Explanations of quantitative and qualitative aspects of this study.

- Explanations of the selection and use of the Dunn learning Style model for this study.
• The methods and procedures of this study, including: the sample population, measuring instruments, the results of three pilot studies, and qualitative and quantitative data analysis.

• The implementation of the study, the use of an informant, and the research strategy.

• Establishment of trustworthiness, and a description of the researcher.

The overarching research question for this study asked: What are the learning style strengths of monozygotic twins and how do they compare? Inherent in this question were specific exploratory questions necessary to address specific elements of the Dunn LS model. Likewise, attention was given to those elements that constitute one’s perceptual strengths and global / analytic elements. Those elements were given priority in comparing the LS of monozygotic twins because they are often the most obvious and influential of all the elements.

Some of the specific questions addressed in the qualitative interviews explored the similarities and differences that each twin had regarding the stimuli categories and the specific elements. For example, each twin was asked to describe their optimal study environment and its particular features. They were also asked to describe distractions to that study environment and to rate qualities, such as light intensity, and their effect on their concentration when learning new or difficult information.

The three research questions introduced in Chapter 1 (Section 1.6.1) guided this study. These were the objectives that guided the researcher. They may be summarized in the following statements:
• What are the learning style strengths of monozygotic twin siblings and how do they compare with each other?

• What do the quantitative and qualitative data reveal about the learning styles of monozygotic twins?

• Do monozygotic twins have similar learning styles as a group and when compared as a set of twins with dizygotic twins?

3.2 Quantitative and Qualitative Aspects of this Study

There is numerical data on the learning styles of people of various ages, cultures, and academic pursuits. However, much of this numerical data can not be useful to parents, teachers, or the individuals themselves unless translated or explained in pragmatic terms. While an overview of the breadth is helpful and contributes to our understanding, there is greater need to understand and explore the finer details and layers of how monozygotic twins learn. Therefore Chapter 4 explores a quantitative study of a large group of twins, together with the quantitative results from the eight twins used in the more in-depth qualitative interviews (which appear in Chapter 5).

These qualitative interviews were suitable and very useful for this exploratory study for several reasons. Among the many previously conducted studies, very few focused on the depth of information of a few individuals. Instead, they opted for broader survey approaches. The research on learning styles warrants a probing of individual differences that can be explored more fully in case studies and with the use of research methods such as in-depth interviews. This study was designed to identify important characteristics of individuals and their learning styles according to those elements outlined in the Dunn model, in both quantitative and qualitative
terms. Chapter 7 documents areas of further study resulting from the analysis of the results.

3.3 The Use of the Dunn Model for this Study

The Dunn LS model is the most comprehensive of all LS models as reported by Griggs (1991), DeBello (1990), Given (1996). It contains and assesses elements covering five major categories that can contribute to how a person learns. The Dunn LS model was developed with over thirty years of extensive testing, research, and implementation studies (Dunn et al., 1990). A recent review of literature on learning styles revealed that of 734 articles published up to and including 1996, over 300 articles were using or reporting on the Dunn model. The Dunn model is preferred for use with teachers and students because of its comprehensiveness and its rich research literature (Griggs, 1991; Given, 1996). These characteristics: comprehensiveness, high reliability and validity, and a large research base, made the Dunn LS model preferable for use in this study.

The Dunn model has a record of proven reliability and test validity (Kirby, 1979; Dunn et al., 1990; Miller & Zippert, 1987). It is one preferred by teachers for practical application and ease of use. Its results are easily interpreted and can be easily utilized and understood by parents and students. Recommendations and practices can be effectively transferred to learning situations. The Dunn model, unlike other LS models, is simple and straightforward in prescribing changes that are congruent with one’s style. The anecdotal and statistical data on the Dunn model is extensive and includes work with learners of every background, academic level and subject, and many cultural and socio-economic levels. This model has also been used to develop strategies
dealing with counseling situations (Griggs, 1991). The wide use and proven reliability and validity of the Dunn model is another reason it was selected as the model to use for this research study involving twins. The Dunn model has reported reliability of 0.74 to 0.87 with seventy percent of the twenty subscales exceeding 0.80 (Kirby, 1979).

While the Dunn model has been used in various settings with various populations of learners, the LS inventory is quantitative in its structure and the way it is processed. Many good and effective research studies have been able to assess and compare large numbers of individuals and their styles using this type of instrument. Although the results of the Dunn inventory are easily interpreted and applied to learning situations, the results are not obtained via naturalistic inquiry. It was the goal of this study to collect qualitative data that will contribute to the knowledge already gathered using the Dunn LS instrument.

Another reason for choosing the Dunn LS model for this study is one of empowerment. The Dunn model emphasizes the empowerment of students (Dunn, 1996c). Application materials and teacher created materials can be designed with individual LS preferences in mind. These materials may be initially created by parents or teachers but can later be made and used by individuals from primary age through adulthood. The Dunn LS model is without question the most practical and useful for this reason. Thus, the practical aspects of such a model make it worthy of research involving the learning styles of twins.

This particular study was a case study of monozygotic twins and their individual learning styles according to the most comprehensive definition of learning styles which
<table>
<thead>
<tr>
<th>Environmental:</th>
<th>Sound</th>
<th>Light</th>
<th>Temperature</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional:</td>
<td>Motivation</td>
<td>Persistence</td>
<td>Responsibility</td>
<td>Structure</td>
</tr>
<tr>
<td>Sociological:</td>
<td>Alone</td>
<td>Pairs / Peers</td>
<td>Adult</td>
<td>Varied</td>
</tr>
<tr>
<td>Physiological:</td>
<td>Intake</td>
<td>Time of Day</td>
<td>Mobility</td>
<td>Perceptual Modalities</td>
</tr>
<tr>
<td>Psychological:</td>
<td>Global</td>
<td>Analytic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These are further explained Appendix A

Table 3.1: Five Stimuli Categories (in bold print) with Specific Elements Investigated in this study

is outlined by Dunn and Dunn (1973, 1993) and (Dunn, 1996a) to include elements and influences appearing in Table 3.1.

From Table 3.1, eighteen elements may be identified as significant factors influencing how one is able to concentrate and process new or difficult information in learning situations. However, for most individuals four or five elements are identified as their strongest preferences and thus are considered to be critical elements of their learning style. Among the four or five elements that constitute a person’s LS strengths, there is often a strong preference for one or more perceptual modality strengths. The perceptual modalities include: auditory, visual, tactual, or kinesthetic preferences. One’s perceptual modality strengths are often very important in determining how one initially receives or perceives new and difficult information (Griggs, 1991; Dunn, 1996b).

3.4 Methods and Procedures

This study embraced the case study approach of becoming involved as participant and researcher to construct meaning, including “thick description” (Geertz,
1973) of the learner’s characteristics and the learning process (Stake, 1995). This involved Stake and Trumbull’s (1982) characterization of the researcher as having maximized opportunities to learn and reflect upon ideas through “naturalistic generalization” (Stake, 1995). This case study was an attempt to give a “constructivist orientation to knowledge” (Erickson, 1986; Stake, 1995) of how identical twins learn in specific ways or with particular preferred styles. One of the aims, as stated by Erickson (Erickson, 1986), was to seek some centrality of interpretation, which flows, from rich interactions in the act of conducting research in the field and working with participants.

This study attempted to build upon information and research experience accumulated in pilot studies conducted over the preceding academic years (1995-1997). Both the Dunn Learning Style Inventory (LSI) and the Dunn Productivity Environmental Preference Survey (PEPS) instruments were used extensively by the researcher prior to this study. These instruments were also chosen for their comprehensive coverage of five major areas in which learning style may be studied. The PEPS is a version designed for adults and was given to the interview participants in this study. The Dunn LSI was designed for use with students in grades five through twelve as was administered to twins for the quantitative comparisons.

3.4.1 Population or Sample

The population that this study investigated was that of dizygotic and monozygotic twins who have shared the same home and rearing environments. Interviewed individuals were monozygotic twins at least eighteen years of age, having completed their secondary school careers, thereby being able to reflect upon experiences of at
least 12 years of formal education. Attempts were made to include male and female pairs of twins in this study.

Eight individuals, four pairs of identical twins, participated in the qualitative part of this study. Participants were selected from a database previously assembled by the researcher. The database included pairs of twins contacted with the help of advertising through local and nationwide twin organizations, the Internet, twin and mothers of twins web sites and resources, local school counselors, teachers, and via personal contact. From a database of 50 pairs of twins, four pairs were selected based on their availability and willingness to participate in the series of interviews. Efforts were made to select male and female participants.

3.4.2 Measuring Instruments and Data Collection

The Dunn instruments allow for a quantitative measure of individual learning styles, as well as a method of comparing quantitative scores among groups or individuals. This is important for evaluating information on specific elements or for large populations. The Dunn instruments also eliminate some human scoring errors by use of computerized forms. The data gathered using the Dunn LS inventories were compared to data obtained in grounded surveys, interviews, and documents collected from the participants. Documents included web pages, email correspondence, and notes written by the interview participants.

Interviews were conducted according to what Patton (1990) calls the “interview guided approach.” Questions covering the five major areas of LS were arranged and planned prior to each interview. Each interview was semi-structured around these questions and areas. Interviews were structured to include many of the aspects Kvale
(1996) advocates such as the search for meaning, rich description, specificity, focus on themes, and interpersonal situatedness, among other aspects of importance (Kvale, 1996)

The importance of this qualitative interviewing in gathering data should not be under-valued, especially since the vast majority of data gathered on learning styles is of the quantitative nature. Limited research has been published on the qualitative aspects or the depth of learning styles and there was a need to uncover the layers that may further our understanding of individual LS characteristics. Such research revealed intricate patterns and mechanisms operating and influencing one's learning style. Qualitative data can also be used to complement data gathered from using the Dunn instruments. There was a need to increase the depth of our understanding of individual learning differences and to ask probing questions that go beyond the scope or capability of traditional surveys. Interviewing allowed for the flexibility and cooperative exploring that can occur between researcher and participant.

Furthermore, follow-up interviews allowed the researcher to verify information that was initially gathered from the Dunn instruments or the initial interviews. Information obtained from a series of interviews was used in conjunction with other data using triangulation. Interviews provided an historic perspective, giving the individuals being interviewed and the researcher an opportunity to reflect upon their formal and informal learning experiences.

Collecting documents, when and where possible, was employed by the researcher in this study. Documents were requested in the course of interviewing when appropriate and included such items as: writing samples, written directions, home pages, and responses to grounded surveys. These documents were examined along with the
interviews and quantitative instrument results to give a more complete and authentic assessment of each participant’s individual learning style.

The researcher had on three different instances piloted interviewing methods and questions. The interview questions had been evaluated and refined with the help of colleagues and experienced researchers. These pilot studies honed the skills of the principle investigator, as well as refined the questioning strategies and methodological considerations.

3.5 Pilot Study Results

The pilot studies conducted prior to this research project were instrumental and helpful in planning and refining research practices and analyzing data from qualitative interviews. Each pilot study was conducted under the auspices of experienced researchers and field investigators. The results of those pilot studies were scrutinized by reviewers and constructive advice utilized in the planning of this research study. What follows is a brief description of each pilot study along with its significance and findings.

3.5.1 First Pilot Research Study

The first pilot study was conducted in the summer of 1996 and was planned to test the effectiveness of using interviewing techniques along with the Dunn LS inventory. An initial set of semi-structured interview questions were created to explore the elements of learning style. The final interview questions are included in Appendix C. Transcribed interviews, along with LS inventory scores provided an opportunity to analyze data. The participants were one pair of MZ twins eleven years old. Their
mother was also interviewed as part of the pilot study. This study provided the researcher with some initial experience to try out interviewing skills and strategies, and to field test LS based questions.

Findings from this first pilot study revealed that interviewing questions and the Duna LS model could be successfully matched providing a rich data source. One of the major changes which resulted from this study was to plan on interviewing participants on several occasions rather than only one time, giving opportunities to further explore and verify statements. It was also decided that interview participants be selected from those who were at least eighteen years of age in order to be able to reflect upon a minimum of twelve years of academic experiences. This initial pilot study also prompted planning for two other pilot studies.

3.5.2 Second Pilot Research Study

The second pilot study explored some of the discoveries and recommendations of the first. It was conducted in the fall of 1996 with a panel of colleagues. The focus of this study was further refinement of interviewing strategies, interview questions, and selection of participants. The refined set of questions and interview situations were developed and tested under various circumstances. The interview skills of the investigator were critiqued and evaluated by peer reviewers. The use of an informant was recommended as a means of developing and clarifying research strategies from the participant’s perspective.

Major findings and changes that resulted from this second pilot study included further refinement of specific questions and their sequencing. Techniques were developed to code and look for patterns among transcribed responses. An informant was
helpful in evaluating the questions, their sequencing, and in suggesting constructive situations that could be discussed in the interviews. It was decided in this pilot study that the Dunn LS inventory not be given in the first interview but later on so as not to unduly influence the participants’ responses. One of the concerns to arise from this pilot study was that of finding or having other ways to document learning patterns.

3.5.3 Third Pilot Research Study

The third pilot study was designed with the idea of collecting additional evidence that could be useful in the analysis of transcribed interviews. A panel of fellow researchers and experienced colleagues helped refine interview strategies, suggested ways to continue to analyze qualitative information, and encouraged the use of grounded surveys or document collection.

Major findings of this pilot study revealed that grounded surveys and collected documents could and did contribute to the analysis of participant interview material. The analysis of transcribed data, grounded surveys, and collected documents provided ample evidence that contributed to a deeper understanding of the learning styles of those interviewed. It was concluded that the combination of these qualitative methods along with the quantitative analysis of the Dunn LS inventory scores was appropriate and fitting for this study.

Another significant finding from this third pilot study was the organizing themes that emerged in the process of analyzing and coding the transcribed interviews, the grounded surveys, and the collected documents. Coding was accomplished with the help of computer software, especially Microsoft Word, which included such features as highlighting, split screen function, underlining, and other features. Cross-referencing
and coding was done including where and how often a particular theme emerged, as well as, its significance to other themes and questions.

3.6 Quantitative Data Analysis

An important component of this study was the collection and analysis of quantitative data on twins and their learning styles. Data from the Dunn LS inventory (for twins in school grades five through twelve) or PEPS (version for adults) were analyzed via descriptive statistical tests and graphic representations. Each twin pair had their LS inventory scores compared with their sibling twin. Attention was given to those elements that are in the ranges of 20-40 or 60-80, not the midrange of 40-60 on the Dunn LS instrument. Scores on the borderline (either 40 or 60) were considered preferences for this study. The most extreme scores (non-midrange scores) were carefully compared.

Graphs and statistical averages were employed to interpret quantitative data and to compare identical (MZ) and fraternal (DZ) twins. Comparisons were made for the twins as a group, as well as the four pairs involved in the qualitative interviews. This data analysis is discussed in Chapter 4.

3.7 Qualitative Data Analysis

Qualitative data analysis, discussed in Chapter 5, was accomplished by considering each of the three research questions. The LS strengths of each of the four sets of twins were compared according to their responses to questions in each of the three interviews. The emphasis and frequency of responses were considered by the researcher as part of the analysis process. Consistencies and inconsistencies were
<table>
<thead>
<tr>
<th>Elements</th>
<th>Characteristic of Global Processors</th>
<th>Characteristic of Analytic Processors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound:</td>
<td>Prefers Sound</td>
<td>Prefers Quiet</td>
</tr>
<tr>
<td>Light:</td>
<td>Prefers Dim. Light</td>
<td>Prefers Bright Light</td>
</tr>
<tr>
<td>Design:</td>
<td>Prefers Informal Design</td>
<td>Prefers Formal Design</td>
</tr>
<tr>
<td>Persistence:</td>
<td>Prefers to Work at Several Tasks and Take Frequent Breaks</td>
<td>Prefers to do one Task at a Time with Few Breaks</td>
</tr>
<tr>
<td>Intake:</td>
<td>Prefers to Snack/ Drink While Learning</td>
<td>Prefers NOT to Snack</td>
</tr>
</tbody>
</table>

Table 3.2: Elements of the Dunn LS Model and Their Global & Analytic Corresponding Characteristics (Dunn, 1996b).

... noted. Responses to questions in different interviews were cross checked for consistency. Member checking occurred as part of the interview process, as well as part of the post interview analysis.

An evaluation of the processing types of each twin was analyzed in terms of global or analytic characteristics. Specific elements of the Dunn LS model correspond to global characteristics, while others are more characteristic of analytic learners. The differences and the intensities of the scores on the Dunn LS inventory were compared. The process and the analysis of these factors were explained using both descriptive statistical tests and anecdotal evidence from transcribed interviews.

Individuals with four or five elements in Table 3.2 under the same category (global or analytic) can be said to be strongly global or analytic in their processing characteristics. Individuals with three elements of the five under the same category can be considered to be mildly global or analytic. Individuals with two elements under the same category can not be considered either strongly global or analytic. An element is a strong preference for an individual, according to the Dunn model, if the score
assigned to that element from the Dunn LSI / PEPS inventory falls below 40 or above 60. The range between 40 and 60 is said to be average and not indicative of strong preferences for that specific element.

The third area of the LS inventory that was analyzed in this study was each twin’s perceptual modalities. The numerical scores of the four perceptual modalities were compared. Those modalities were: visual, auditory, tactile (or tactual), and kinesthetic. It is common for individuals to have strong preferences for one or two of these perceptual modalities. The scores for these specific elements are discussed and described in the results.

3.8 Procedure and Implementation of Study

The procedures were carefully structured based on previous pilot studies and other research experiences that prepared the investigator for this extended study. The steps, in chronological order, were:

1. The researcher located, contacted, and planned initial meetings and arrangements for participants in this study. He obtained consent and permission to participate forms and had his research proposal approved by The Ohio State University’s Human Subjects Review Board. Arrangements were made for initial interviews with participants. The literature on twins and learning styles was reviewed. The dissertation committee approved the proposal for this study. (November-December, 1997)

2. The researcher held and recorded initial interviews. Transcription of data from recorded interviews. Document collection began following the first interview. (December, 1997 - March, 1998)
3. The second round of interviews began and the transcription of interviews continued. (March - May, 1998)

4. The third round of interviews and the final collection of documents and survey responses were completed. The Dunn Productivity Environmental Preference Survey (PEPS) was given and sent for processing. (May - June, 1998)

5. Transcription of interviews was completed prior to PEPS instruments interpretation. Final Member checks were completed using transcribed data. (June - July, 1998)

6. Analysis of interview data continued and verification of participant responses was accomplished. The analyzing of PEPS results and correlation of those with interview data was completed. (July - August, 1998)

7. Coding and thematizing was accomplished. (August, 1998)

8. Findings and results were documented. (August - September, 1998)

Much of the groundwork for this study had been completed in the pilot studies. The interview questions had been designed and pilot tested with pairs of identical twins. The questions covered the categories and elements of the Dunn LS model. A list of the questions that were used as guide questions is included in Appendix C. Information on where to obtain the Dunn LS inventory or PEPS instrument is included in Appendix B.
The need for a minimum of three interviews was determined in pilot study research. Participants benefited from having interviews spaced at least 5 days to one-week apart and allowing time for reflection on their previous school and learning experiences.

3.9 Use of Informant

An informant, who was himself an identical twin, was employed to help phrase and test the battery of interview questions prior to their field testing in pilot studies. Likewise, the informant and several peer researchers critiqued and assessed the procedures and types of interview questions and their effectiveness in practical and authentic settings. The methods were critiqued by fellow researchers prior to the pilot studies and in preparation for the collection of data. Constructive comments and critiques were then applied to refine and improve the interview questions and the research methods.

3.10 Research Strategy

The research strategy employed in this study was the case study approach. Eight individuals were selected for participation in three in-depth interviews. Interviews covered the elements of the Dunn learning style model. Interviews were structured such that they built upon each other and explored each of the categories of the Dunn LS model. The second and third interviews allowed the researcher to revisit and recheck responses given in the first and second interviews. Member checking was part of the interview process of the second and third interviews, as well as part of the final stages of data analysis.
Information collected consisted of documents or written samples of the participants' formal or informal educational experiences. These were requested of participants when appropriate and helpful in relating to their individual learning style. Some of the documents included personal web pages, email correspondence, and notes written by participants. Grounded survey questions were used in conjunction with the interviews to illuminate and guide the researcher's inquiry. An example of the grounded survey items have been included in Appendix E and appendix F.

Each interview participant took the Dunn, Dunn, and Price LS inventory version called the Productivity Environmental Preference Survey (PEPS). Their scores were interpreted following the interviews as another source of data to be analyzed along with transcribed data from interviews and documents.

In summary, data was assembled and analyzed from the following:

- interviews
- documents (including: web pages, email messages, and notes)
- Dunn, Dunn, and Price LSI / PEPS
- grounded survey questions

3.11 The Case Study Approach

The employment of the case study for this research allowed the researcher the opportunity to probe more deeply the topical areas outlined previously. It afforded opportunities for the participants to construct and reflect upon personal meaning and interpretation of how they learn. Unique interactions and characteristics were
discussed and investigated with follow-up questions in the interviews. The case study approach has the following qualities condensed from Stake (1995):

- it is holistic and is contextually based
- it seeks understanding and is relatively non-comparative
- it is empirical and field-oriented
- it emphasizes naturalistic observation and "natural language description"
- it is interpretive and requires researcher(s) to use both intuition and on-site observations
- it is subjective and values the researcher-participant interactions
- it is empathic and seeks "actor frames of reference" and value commitments
- it includes a design that is emergent and responsive to the needs and issues arising in the course of conducting research.

These qualities facilitated the collection of data that was rich in detail and description.

3.12 Establishing Trustworthiness

Trustworthiness was established by using various data sources and comparing them for patterns. The semi-structured interviews provided opportunities to review and revisit themes or experiences that illuminated individual learning preferences and patterns. Document collection and grounded surveys provided alternative sources of
data that added depth and increased opportunities to verify patterns. Data from these methods was analyzed and compared using triangulation.

Member checks were conducted with the participants in the second and third interviews, as well as in the final steps of analysis. Participants were in contact with the researcher for a duration of one to six months and they had opportunities to verify and question transcribed material. Transcribed interview data included anecdotes, quotations, vignettes, and completed grounded surveys used in conjunction with interview questions.

The researcher kept a journal of reflections and observations following each interview. This served as another device intended to draw attention to the researcher’s perspective and the collection of information that complemented transcribed data.

Data was coded with a system of letters and numbers for future reference and tracking. Letters were used to signify the names of each interview participant and to ensure anonymity. Numbers were used to signify the section and sequence of the interview. For example: 33Ar.2.2 indicated an interview of participant “Ar,” which was the second interview and the second page of that transcribed interview. A prefix number (before the letter code for the participant) corresponded to the sequential section of that transcribed interview. Tape recorded copies of each interview were labeled and cross referenced to transcribed data using the same coding system of letters and numbers. References to the interview data and transcriptions were cited using the codes in parentheses that followed each quote or data reference.
3.13 Description of the Researcher

Since the researcher is instrumental in working with the participants in order to explore and interpret meaning with them, it is important to identify some of the characteristics of the researcher. The researcher’s teaching and research experiences were beneficial and useful throughout this study.

The researcher was a 37 year old Caucasian male familiar with education at various levels and institutions. He attended parochial and public schools and had taught math and science to students from grades five through College. He completed his undergraduate degree at Ohio Dominican College in 1982 and later completed his MA degree (1992) in Science Education at The Ohio State University while teaching middle school in the Columbus metropolitan area. He began his doctoral work in 1994 and specialized in science teacher training, learning styles research, and brain based research with classroom and instructional applications. The researcher plans to continue both teaching and research interests.

The researcher had applied and theoretical experience with qualitative research methods, finding those to be compatible with his own desire to achieve a depth of understanding and attention to rich descriptive details. Interview techniques and personal skills had also complemented his desire to work with individuals and small groups to explore contextual educational issues.

3.14 Summary of Research Methods

The following points summarize research methods and considerations that are central to this study:
- Quantitative comparisons were used to compare Dunn LS profile scores across the four cases in the qualitative study, as well as to compare the Dunn LS scores of samples of MZ and DZ twins.

- This study involved the collection of detailed and descriptive data using a series of three interviews per individual, the collection of documents such as web pages, and email correspondence, and grounded surveys.

- The qualitative study participants were four pairs of monozygotic twins who were studying and preparing for science or technological careers.

- The Dunn learning style model was used to assess LS strengths.

- The three pilot studies conducted prior to this study contributed to both the design of the research methods and the skills of the researcher.

- The researcher made use of member checking throughout the second and third interviews. The researcher also triangulated data obtained from the interviews, grounded surveys, and documents collected, and the Dunn LS profile scores. These helped establish trustworthiness.
CHAPTER 4

PRESENTATION AND ANALYSIS OF QUANTITATIVE DATA

4.1 Introduction

This chapter discusses the quantitative comparisons that were made of the Dunn LS profiles of seventy-six identical and thirty-six fraternal twins. The quantitative results indicated that although monozygotic twins are more homogeneous as a group than dizygotic twins, individuals of either twin type share very few of their LS strengths with their sibling twins.

This chapter also discusses the quantitative data obtained for the four pairs of twins used in the qualitative interviews. Their scores are presented graphically. Many of their LS profile scores were not shared between each pair, much like the general quantitative group.

4.2 Data Collection

Quantitative data was collected as part of this study for the express purpose of providing baseline data for future exploratory research. The data consisted of having monozygotic and dizygotic twins complete versions of either the Dunn, Dunn, & Price
learning style inventory designed for use with students in grades five through twelve, or the Dunn, Dunn, & Price Productivity Environmental Preference Survey (PEPS) version for adults. Survey information was collected simultaneously as this study was planned and executed.

In the two years of planning this research, Dunn LS inventories were collected from eighteen dizygotic (DZ) twin pairs and thirty-eight monozygotic (MZ) twin pairs. On considering the use of quantitative statistics for some of these comparisons, it became evident that no reliable statistical measures had been developed for use with only two individuals and their limited number of scores. Therefore, it was decided that the following be compared:

- The number of LS strengths for DZ and MZ pairs.
- The number of shared and concordant LS strengths for DZ and MZ pairs.
- The number of shared and discordant LS strengths for DZ and MZ pairs.
- The number of shared perceptual strengths for DZ and MZ pairs.
- The above comparisons, considering age as a possible effect.
- A graphical comparison of the number of common and uncommon strengths of each of the eight interview twins based on their Dunn LSI profile scores and the areas of overlap.

4.3 Quantitative LS Strength Comparison

Several LS strength comparisons have been performed for all 112 twins. A comparison of the average number of LS strengths for each twin type was performed. A
<table>
<thead>
<tr>
<th></th>
<th>DZ Pairs</th>
<th>MZ Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean # LS Strengths</td>
<td>13.11</td>
<td>14.39</td>
</tr>
<tr>
<td>Mean # LS Strengths Shared Among Twins</td>
<td>1.89</td>
<td>3.50</td>
</tr>
<tr>
<td>Mean # LS Strengths Discordant Among Twins</td>
<td>1.0</td>
<td>0.26</td>
</tr>
<tr>
<td>Mean # Perceptual Strengths Shared Among Twins</td>
<td>0.11</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Table 4.1: Comparison of LS Strengths

comparison of each twin’s LS shared strengths was performed, both concordant and discordant. Finally, a comparison of only the perceptual strengths was performed. The resulting tabulated data appears in Table 4.1.

While DZ and MZ twins had similar numbers of total LS strengths, MZ pairs showed nearly double the number of shared strengths relative to DZ pairs (3.5 vs. 1.89, on average). DZ pairs, on average, had at least one shared strength in which they were discordant (e.g., one strongly preferred dim light; the other, bright). MZ pairs, on the other hand, averaged one fourth this amount, or 0.26 strengths. Thus, MZ pairs shared more strengths in general and had fewer opposite strengths than the DZ pairs. In addition, MZ pairs shared a much greater number of perceptual strengths than DZ pairs, but still a small number overall (0.62 strengths, on average).

A more detailed comparison of the perceptual modality LS strengths of MZ and DZ twins (see Table 4.2) indicates that thirty-two percent of the group of MZ twins had one perceptual modality strength in common as compared to eleven percent of the group of DZ twins. Only six percent of the group of MZ twins had two perceptual strengths in common, as compared with none of the DZ group of twins. While fifty-six percent of MZ twins and eighty-nine percent of the DZ twins in this sample had no perceptual strengths in common.
<table>
<thead>
<tr>
<th>18 DZ Pairs</th>
<th>Percent (DZ)</th>
<th>Common Perceptual Strengths</th>
<th>34 MZ Pairs</th>
<th>Percent (MZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>89</td>
<td>None</td>
<td>19</td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>One</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Two</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Three</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 4.2: Comparison of the Shared Perceptual Modalities of MZ and DZ Twin Pairs

4.4 LS Strength Comparison: Age as a Factor

In an attempt to control for age, the comparisons in Section 4.3 were performed again based on just seven pairs of MZ and seven pairs of DZ twins. The seven pairs were chosen such that each DZ pair has a similarly-aged MZ pair. In addition, the seven pairs were no younger than seventeen and no older than twenty-five. This assured at least twelve years of schooling. Interviewed twins were not included in this comparison.

A summary of the results appears in Table 4.3. While the means differed in value in each case, the general trends and observations still hold. Specifically, MZ pairs show slightly less than twice the number of common shared strengths and one-sixth as few discordant strengths versus their DZ counterparts. Again, perceptual strengths were more common among MZ pairs, but uncommon overall.

4.4.1 Graphical Comparisons of the Strengths of Identical Twins

Figures 4.1–4.4 compare the strengths of the twins interviewed in this study graphically. Scores sixty or above and forty or below are considered strong preferences of individuals on specific elements. The graphs display those scores that show strong
<table>
<thead>
<tr>
<th></th>
<th>DZ Pairs</th>
<th>MZ Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean # LS Strengths</td>
<td>13.28</td>
<td>13.14</td>
</tr>
<tr>
<td>Mean # LS StrengthsShared Among Twins</td>
<td>2.0</td>
<td>3.57</td>
</tr>
<tr>
<td>Mean # LS Strengths Discordant Among Twins</td>
<td>0.86</td>
<td>0.14</td>
</tr>
<tr>
<td>Mean # PerceptualStrengths Shared Among Twins</td>
<td>0.14</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Table 4.3: Comparison of LS Strengths, factoring in Age (7 pairs DZ, 7 pairs MZ)

preferences by one twin or the other. Elements that were neither twin’s strength are not shown on these graphs.

Carl and Jay’s profile results appear in Figure 4.1. They only had one common shared LS strength in their preference for the kinesthetic perceptual modality. Thus, they did not share the majority of their LS elements as strengths, nor did they have any discordant strengths.

Ann and Jill had two common shared LS strengths in their preferences for warm over cold temperatures and in their preference against studying / learning in the morning. They had no discordant strengths. Again it is evident that most of their LS strengths were not in common, as shown in Figure 4.2.

John and Jeff shared six LS strengths in common. Although they had the auditory perceptual modality as a common strength, Jeff had a second perceptual strength: tactual, which was not a strength of John’s. Five LS elements are shown on the graph in Figure 4.3 that are strengths of either John or Jeff, but were not shared. Again, as in the previous two pairs, John and Jeff shared no discordant strengths.

Mike and Dan had three LS strengths in common. They shared a preference for structure and for visual and tactual perceptual modalities. Dan’s profile also
Figure 4.1: Carl and Jay’s LS Strengths. Carl’s strengths are represented by the black bar; Jay’s, the white bar.

Figure 4.2: Ann and Jill’s LS Strengths. Ann’s strengths are represented by the black bar; Jill’s, the white bar.
Figure 4.3: John and Jeff’s LS Strengths. John’s strengths are represented by the black bar; Jeff’s, the white bar.

Figure 4.4: Mike and Dan’s LS Strengths. Mike’s strengths are represented by the black bar; Dan’s, the white bar.
indicated that he did not prefer to be exposed to new or difficult information by auditory modes. Dan had six other elements with strong preferences that were not shared with Mike, as shown in Figure 4.4. While they had no discordant strengths, a majority of their strengths were not shared.

4.5 Summary and Comments

The quantitative data and subsequent analysis provided an interesting look into the differences in learning styles of DZ and MZ twins. While both types of twins had similar numbers of strengths, MZ twins shared more common LS strengths and fewer discordant strengths. They also had more perceptual strengths in common versus their DZ counterparts.

However, looking exclusively at the strengths of MZ twins (including the eight interviewed twins), it is clear that they do not share most of their strengths with their sibling twins.
CHAPTER 5

PRESENTATION OF QUALITATIVE DATA

5.1 Introduction

The four pairs of monozygotic twins interviewed for this qualitative study were selected based on their interest in science and their pursuit of science-related professions. They were given aliases to assure anonymity and confidentiality. Data gathered from the in-depth interviews is presented for each pair of twins.

Each pair is discussed and data presented that relates to the groups of elements (stimuli categories) presented using the Dunn Model. As a reminder, scores 20-40 and 60-80, inclusive, indicate LS strengths, while scores 41-59 do not indicate LS strengths. The quotations cited were selected for their consistent reflection of LS characteristics. They were selected from among many that helped provide a detailed description of each twin sibling’s learning style. Tables follow each selection of quotes that summarize specific LS elements.

The interviews were conducted such that each covered the five categories that Dunn referred to as stimuli. Interview questions from the second and third interviews were structured so that additional probing of specific LS elements could occur. The second and third interviews, likewise; provided a means of checking and revisiting
earlier responses from previous interview(s). This allowed the researcher opportunities to seek clarification and elaboration of specific LS elements as needed.

Summary tables for all the twins are presented at the end of this chapter in Tables 5.25–5.30.

5.2 Carl and Jay

Carl and Jay attended a private mid-sized undergraduate college in Ohio and both majored in the sciences. Carl majored in chemistry, Jay majored in biology. Both went on to graduate schools immediately following the completion of their bachelor’s degrees. Carl is now studying chemistry at a prestigious California university, while Jay is pursuing medical school at a prestigious Midwestern university. Both appeared as highly motivated young men who have a curiosity about the natural world and have enjoyed nature and camping since childhood.

5.2.1 Environmental Characteristics of Carl and Jay

When sound was discussed as an element of one’s personal learning style, each expressed the need for a quiet study environment, at least when they were beginning to study. They each mentioned the importance of having a quiet time to focus, usually during the first fifteen minutes of their study time when, as Jay described it, “you’re just trying to get into it, you feel like you’re sinking into the material.” After the initial period of quiet, noise in the background, as long as it was somewhat subdued, did not bother either of them. Sound, for each of them, appeared not to be a major part of their learning style on the Dunn LSI, Carl’s profile score was 58, Jay’s was 54.

On the preference for light in one’s study environment, neither Carl nor Jay expressed definite preferences. Carl expressed on three different occasions that bright
<table>
<thead>
<tr>
<th></th>
<th>Carl</th>
<th>Jay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound:</td>
<td>I(first 15 minutes)</td>
<td>I(beginning)</td>
</tr>
<tr>
<td>Light:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature:</td>
<td>I(warm)</td>
<td>i(warm)</td>
</tr>
<tr>
<td>Design:</td>
<td></td>
<td>I(informal)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.1: Environmental LS Elements of Carl and Jay

Light would be preferred to soft lighting, but it did not appear important when discussing his optimal study environment, when he said: “lighting isn’t too much of a concern.” Jay likewise, said that lighting does not seem to influence his level of concentration when he studies. The Dunn LSI scores revealed that light was not an important consideration when learning. Carl’s profile score for light was 51, while Jay’s was 44.

Temperature proved to be an important element in the learning style of Jay. Jay expressed a preference for warmer temperatures when trying to learn new or difficult information. He expressed the need to often cover his legs and feet with a blanket, and found cooler temperatures a distraction when studying. Carl however, did not express the same preference for warm temperature. Although Carl did say that “warmer is better than cooler,” temperatures when studying, he also expressed the idea that it was not very important for him and his study environment. Carl’s LSI score for temperature was 52; Jay’s was 61.
The fourth element of the environmental stimuli was design. Carl’s preference was for formal study environments with traditional desk and chair arrangements. He would often study in the computer lab as an undergraduate because it consisted of large tables and few distractions. But he did not express design as being of major importance to his learning style. Jay however, expressed a preference for informal design when studying. He described times when he would try to go to the library and study and after a short time would find himself going back to his dorm room because the informal surroundings were more comfortable for him. He emphasized this on several occasions. Jay emphasized that being comfortable and in familiar surroundings is important when studying, and that desk space is not necessary for him to do much of his studying. Carl’s LSI score for design was 48, while Jay’s was 34. Jay’s LS score agreed with his preference for informal design.

5.2.2 Emotional Characteristics of Carl and Jay

The emotional elements and questions revealed some of the greatest similarities among Carl and Jay. However, these elements did not stand out as major influences on their ability to learn or study new and difficult information. Their similarities however, do deserve discussion here. Both Carl and Jay mentioned the role scouting had in developing their appreciation of nature and science. They also mentioned the role their parents had in encouraging those same pursuits. Likewise they had many good science and math teachers who inspired them to excel in those areas. Grades were important to them, however; they never really were motivated by them and they did not compete or compare grades as many of their friends might expect.
Carl and Jay demonstrated similar responses on questions of motivation. And although both stated that they were very motivated and interested in doing well, especially in their college and graduate research pursuits, they also admitted a real tendency to procrastinate.

Carl is motivated by the excitement of new ideas and discoveries that can occur in scientific research.

Every time someone comes up with a drastically new definition, like Einstein did...that’s where the fun is. So, I think a lot of people, they’re always trying to improve on things. When I saw that at first, that really turned me on to science. (42C.2.10)

The freedom to experiment and explore is motivational for Carl.

Well, I spent the summer in North Carolina and I was pretty much treated as a graduate student. It was really great because he (the supervising professor) was so ‘hands off.’ And people there were great and treating me as a colleague. And I just loved that. (35C.2.8)

Carl’s desire to know more about the world and his curiosity were obvious in the interviews. On at least three different occasions he mentioned the role that a sense of curiosity played in motivating him in his studies. He also emphasized the importance of establishing a reputation of being a thorough and accurate researcher.

Jay’s desire to learn and motivation was similar to Carl’s. Both were more motivated by internal than by external rewards. Both mentioned that they didn’t expect or need frequent encouragement from others or from grades as indicators of their ability. They were more motivated by the personal satisfaction of knowing more and being able to contribute to research in their fields. Jay liked to work with details and to discover things for himself. That way he feels is more ‘exciting’ and open to innovation. The self discovery of research made research rewarding for Jay. (32J.2.4)
Jay is motivated by open-endedness of research and he prefers to go out and try something new rather than have someone tell him exactly what to do and the results. “I think I got into college and the subjects started getting more serious, more challenging, and I started getting more interested.” He also made the point that he prefers non-repetitive work as assignments and work that allows more opportunity for innovation and discovery. (22J.2.1)

Both Jay and Carl could be considered highly motivated learners. However, their motivation appeared to be dependent on their level of interest and involvement. Thus, their motivation is somewhat situational. Their Dunn LSI scores for motivation were identical. Carl and Jay both scored a 57 on their profiles.

On persistence, both Carl and Jay commented that it can vary with their level of interest and whether a learning task is self-directed or given by someone else.

Carl described himself as ‘fairly persistent’ at learning tasks and assignments. He spoke of working on tasks with ‘bursts’ of energy. He commented, “if it’s really important, I should get started on it immediately, or else my procrastination will kind of kick in and the burst won’t come till later.” He continued, “I’m able to be fairly persistent. I think about things and I can do them in bursts. And so, I’m not so much good for the long straight haul, but...I can get it done.” (18C.2.2)

Jay responded to questions on his persistence at learning new or difficult information with the following statements. He said that he usually finishes or carries through on tasks, even if they are sometimes done close to deadlines. On speaking of his persistence at trying to figure tasks out for himself, Jay responded with the following.

I always try and beat through it, and then after like five hours of failure, I’ll finally admit defeat. Especially if I, it’s almost comical that, I mean sometimes...I have a task to do, and I’m supposed to it on the computer
or something new or whatever, I will just sit there. I remember I had a spreadsheet assignment for analytical (chemistry) and what I had realized, there was something missing. I sat there for seven hours trying to get this thing to work. And I could not, so I finally had to say, ‘I can’t get this.’ So someone said, ‘just do this,’ and ahhh (loud with expressive voice and laughter) ...But I will beat at something. I don’t know why, maybe it’s ego or something. I don’t know. I do persist. (93J.3.9)

Both Carl and Jay expressed similar levels of persistence at learning tasks with Jay’s responses being more descriptive, as above. On the Dunn LSI profile for the element persistence, Carl scored 53 and Jay scored 58. Persistence was not an obvious learning style strength of either Carl or Jay.

On the emotional element of responsibility, both Carl and Jay echoed many of the similar responses to interview questions. Carl stated, “I feel a responsibility to my own reputation. I want to maintain a decent research reputation. That’s who I feel most responsible to, is myself.” (20C.2.2)

Carl is more responsible when it comes to completing tasks that are given by others, rather than ones he selects for himself. He also distinguished between routine or class tasks, which have known outcomes, as opposed to research tasks where the outcomes are novel or unknown. (19C.2.2)

Jay echoed some of the same ideas in his responses.

I was taught real young that you have to take responsibility for your own actions. It’s really weird, but it’s almost a key to my persistence, is it’s my responsibility, never anyone else’s. I mean even if I’m just involved in it, I’m responsible. So, it’s almost like, if I didn’t take responsibility, I’d be really ashamed. It’s like a deep-seated thing with me...I make it very personal. (30J.2.3)

He continued to explain the difference in being responsible for personal tasks and choices in learning and those given by others.
...I'm personally responsible for this, especially if someone else gives it to me. Cause, if it's my own kind of thing then, if I just picked it up or whatever, the responsibility isn't very heavy. But if someone else gives it to me, I feel very responsible to them. And very, you know, if I were to fail them, they might not even be upset or anything like that, but I would feel terrible. You know, it’s just, I mean, it’s just something, I guess it's just part of who I am. I guess? (30J.2.3)

On the Dunn LSI, Carl’s score for responsibility was a 54, while Jay’s score was also a 54. Jay’s remarks were much more emphatic than Carl’s on this issue of being responsible to others for learning tasks. However, Carl did reflect a similar sense of responsibility when he was in teaching situations, as he had served as a tutor and teaching assistant in some summer courses.

The fourth emotional element was that of structure. There was a similarity in how Carl and Jay responded. Neither said that they rely upon lists or make use of calendars or planners to help them organize their study routines. On the Dunn LSI profile Carl’s score in this area was 47 and Jay’s was 44. Structure was not an important element in either of their learning styles. Table 5.2 displays the emotional LS elements of Carl and Jay; however, none were strengths on their LS profiles.

5.2.3 Social Characteristics of Carl and Jay

Both Carl and Jay expressed a preference to study and learn by themselves rather than in small groups, with one other person, or in teams. They each had experiences working with others in research groups and understood the necessity of such arrangements. However, they preferred to have worked or prepared for such group interactions by themselves. Even though Carl and Jay attended the same college and had taken some of the same courses, they did not study together. They did not study together in high school, either.
<table>
<thead>
<tr>
<th></th>
<th>Carl</th>
<th>Jay</th>
</tr>
</thead>
<tbody>
<tr>
<td>motivation</td>
<td>I(informal Lrn. Exp.)</td>
<td>I(informal Lrn. Exp.)</td>
</tr>
<tr>
<td>persistence</td>
<td>I(procrastinate)</td>
<td>I(procrastinate)</td>
</tr>
<tr>
<td>responsibility</td>
<td>I(in research/teaching)</td>
<td>I(in research)</td>
</tr>
<tr>
<td>structure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.2: Emotional LS Elements of Carl and Jay

In six specific and separate instances during the interviews, Carl emphasized that he works best at learning tasks alone. He mentioned times when he would do research alone and then share his findings with fellow researchers in a group. Carl mentioned that conducting research as a group is difficult and “it usually ends up being too many cooks in the kitchen.” (27C.2.5) In situations where he did seek help, he would most likely approach one other person, usually a professor or lead researcher. (59/60C.3.3)

Learning by myself is the quickest way I learn. If it’s a really challenging topic and I really don’t understand it, but there’s someone else who understands it, usually just a little time with one other person, say one on one with a professor, is best. (26C.2.4)

Carl also has taught himself different computer software languages and applications.

I was sitting around one afternoon, night before winter break and I thought ‘boy, it would be great if I could program this thing (his Macintosh Computer).’ So, I picked up a book on C and I first learned C over winter break, and I bought this book: Learn C on the Macintosh, and I learned C on the Macintosh.
Carl went on to say that since he did have some background courses in computer programming and he was familiar with the use of abstract variables, it was "basically like I already know how to ... use a hammer to hit the nail with. I just learned how to use a nail gun. That’s basically all it was.” (47C.2.12)

Jay’s social learning preference was summed up with the following.

If I’m fairly comfortable and feel like, any new material I could learn pretty easily, and I really don’t have to worry about it that much, then group learning is perfectly okay with me. But most of the time, I prefer to be by myself, especially when I’m trying to work something out.

He made it clear that it can be annoying when people try to explain something that he’d rather work out for himself. (65J.3.2)

And sometimes I’ll even find my own way to do it. Not everyone does it the same, and sometimes I find different ways. They’ll want me to do it one way, and I’ve already figured out some other way to do it. I just kind of ignore what they say and do it my own way. (laughs a little upon saying this) Especially if it works. (66J.3.3) If it’s something I really don’t understand, I really like to be alone. I mean I really prefer that, because it’s kind of like, you really don’t understand anything, you don’t have a clue, and all I want to do is go aside and sit and learn something about it. (36J.2.5)

Jay also emphasized working by himself prior to working in group situations, such as in research groups.

If I can come to the conclusions myself, I find I learn it much better and it’s almost annoying to work with someone else. And then once I understand it well enough, then I can go into a group setting and sit there and discuss it and that helps me a lot too. But I really have to have an understanding of something before I can work, start working in a group session. (36J.2.5)

On the Dunn LSI profile Carl’s standard score for learning alone or with peers was 43 and Jay’s was 50. This was one area where there was clearly evidence from
<table>
<thead>
<tr>
<th>Type</th>
<th>Carl</th>
<th>Jay</th>
</tr>
</thead>
<tbody>
<tr>
<td>self</td>
<td>I+(alone)</td>
<td>I+(alone)</td>
</tr>
<tr>
<td>group</td>
<td>I(dislike)</td>
<td>I(dislike)</td>
</tr>
<tr>
<td>authority figures</td>
<td>I(Wants)</td>
<td>D(Wants)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.3: Social LS Elements of Carl and Jay

the interview data that each had a preference for learning alone, yet this was not indicated on their LSI profiles. In member checking this, again each confirmed their preference for learning alone.

On the second scale of social learning stimuli, that of preferring authority figures present or absent in learning situations, there was a difference between Carl’s and Jay’s preferences. Carl’s profile revealed a preference for authority figures present, a score of 63, while Jay’s score 54, did not reveal a clear preference.

In an additional note regarding social learning experiences, Jay had selected an independent study option in medical school, which allows him to complete the greatest majority of his work and studying alone. And following his first year of medical school, he reported that it was still his preference and it was working out as he had anticipated. Carl and Jay’s social LS preferences are shown in Table 5.3.

5.2.4 Perceptual Modality Preferences of Carl

Carl and Jay have more than one perceptual strength according to data collected from interviews, grounded surveys, and the Dunn LSI profile. In the course of the
three interviews each responded to many items regarding their perceptual strengths. Upon analyzing the transcript data and comparing responses for consistency, correlating these responses to other sources, as well as following up with questions on the member checks, several inconsistencies persisted.

Carl’s perceptual strength according to the interview data was tactual and visual as many of the following responses revealed.

“I listen to lecture, write it down. I don’t need to review it...” He went on to explain that in lecture situations that he was unable to attend, he would prefer to have the notes of the lecture as opposed to receiving an audio tape of the lecture or an audio tape and the notes. (79C.3.7) He also explained that he would rather read and hear new information presented, rather than just hear it in lecture or just read it. (71C.3.5)

Regarding laboratory work, Carl responded that he thought there was no substitute for lab work and that he prefers to “experiment around a little, the actual manipulation of something with my hands.” (55C.3.1)

In another place Carl emphasized the importance of writing down information from a lecture:

And I found that I really didn’t even use my notes, it was just the fact that I was writing it down that kind of helped organize my thoughts as the professor was thinking. I never really go back to my notes. I think for me, it’s a way of organizing my thoughts, and then of course going back to the textbook and seeing what they were talking about and knowing more about it. (1C.1.1)
He also gave examples where he preferred information to be presented visually:

“It’s helpful to have professors write information on the chalkboard and use visual aides and assigned readings, because it helps emphasize that it’s important.” (98C.3.7) This was emphasized other times as in the following quote:

For me, if they (professors) speak and give a diagram, that’s the best, and if I can happen to take notes, that’s really helpful. But I like them to see it and I like them to write it, and I like to write it myself, and then that’s the best combination. If they just speak, and describe, that’s not usually enough for me to really get it. (12C.1.4)

Carl responded to some learning situations by indicating that he finds information displayed graphically very helpful. He stated that he’s skillful and prefers to make and use graphic displays of data. There were times he found it more useful to have a graph display information rather than have a paragraph explain the same information.

“Just one look will tell you a thousand words.” (77C.3.6)

Carl’s preference for tactual experiences was evident in his computer skills. He has taught himself different computer languages, as well as, having taught himself how to create his own web page complete with sophisticated graphics. His web page was considered evidence of his skills and included many visual models demonstrating some of his research interests in chemistry. From the interview data, Carl’s perceptual strengths were considered to be visual and tactual. At one point he explained how he taught himself to juggle by watching others and by experimenting on his own.

The Dunn LSI profile indicated that Carl’s perceptual strength was auditory (64), kinesthetic (63), and then tactual (57). In an embedded survey within the interviews, Carl’s perceptual strengths were shown to be visual and auditory.
5.2.5 Perceptual Modality Preferences of Jay

Jay’s perceptual strengths from the interview data were also tactual and visual as the following excerpts indicate.

On learning anatomy as an undergraduate student: “since anatomy is so much different, no diagram ever does it justice. You really have to see it to really understand what it is.” Jay went on to speak about chemistry.

I had no problem, as long as, I always need some way of visualizing. But once you have that good model in your head, and you kind of update that as I learn more, then you can apply that to more and more situations, eventually it’s just, anything new is no problem. (18J.1.6)

Once Jay is really into his lab research or studying, he doesn’t notice the background noise or music.

If it’s quiet, it’s okay, but if it’s, like I said, when I’m first trying to study, it’s more annoying then, than if I’ve already been studying and someone flips the music on. I won’t even probably notice that the music’s on. (71J.3.4)

He went on to mention times in the research lab where he worked for the summer when the CD would flip off and he wouldn’t notice that it quit playing for about thirty minutes. (71J.3.4) This was taken as an indicator against a preference for sound in the background.

Given a list of preferred learning modalities including auditory, visual, kinesthetic and tactual, Jay selected kinesthetic as most preferred for him in learning situations. “Probably the whole body thing (kinesthetic), actually doing whatever. If you’re going to teach me something, then probably actually doing it with them would be the best way for me to learn how to do it.” He went on to emphasize the importance of doing lab work in science, even though it can be dry and repetitive at times. (59J.3.1)
Again, Jay emphasized his preferred way of learning new or difficult information when he said the following:

Probably, getting everything involved...Yeah, yeah. When I can, you know, see it, hear it, touch it, someone saying, and I'm actually doing it, it's so much better, I think. It's like I've always thought that school should have more field trips, because they are really good for learning about something. I mean it gets you out of the classroom and you actually get to see and do something. (74J.3.5)

Jay eagerly explained the importance of field trips for himself. He emphasized the value of using multiple senses to process new information and make connections with previous experiences. The following two quotations highlight his ideas.

Field trips are a way to get your hands on something or see, like after they talk about an application and then let's go look at something. I learn things very well, with just the diagrams and the discussion, the lecture notes, but if I'm going to remember something for the rest of my life, actually doing it with my hands or seeing someone else do it, and seeing how it works (emphasis on works), then I'll not only just learn it but that's engrained forever. (19J.1.6)

If I can see it, touch it. They tell me, 'this is what this is, this is how it works,' then I'll never forget it. It's there forever, because I don't know, it seems like the associations in my mind help me to learn it. I used to get upset because a lot of material is 'babied up' especially in introductory courses and things. 'Well, how does that work? Don't worry about that, you'll get that later.' (emphatically) Well, that doesn't help me. It actually helps me to have it more in-depth. I find I learn better in in-depth courses because if I can understand how it works and how it's interacting with other things, more of that association, the more of that information I can have, the better I learn it. Because I see that and I remember, 'oh yeah, that works this way.' Like I said, if I can see it, touch it, see how it interacts, then that's it for me. (17J.1.6)

Jay benefits by using and integrating multiple perceptual modalities in his learning experiences. He went on to explain the importance of integrating two or more perceptual preferences:
Writing down must be an important thing for me because I really tend to take notes on a mental, just kind of mental, it's almost like unconscious. I mean I see what I'm writing and everything, but it's just kind of trying to remind myself to help me process, that whole taking notes thing. If someone's explaining it, definitely drawing diagrams on the board is going to help. That helps me, the whole visual, that goes along with, because someone telling me, 'you do this, you do this,' I think I'd learn it much better if they showed me a picture and say 'this is how it works.' I can learn either way, but especially seeing something, and especially if I get my hands on it. (16J.1.5)

Jay’s comments were very descriptive. He described his reliance on more than one perceptual modality in the following quotes. For Jay, having new information presented in only one way is limiting. He explained that in lecture situations he often takes notes as a way of helping him process information.

If I can see someone doing something than even, if it’s them talking about it, it’s better than just listening to some tape recording. Yeah, I mean, that’s probably the worst possible way I could learn about something is to just have someone do a lecture, tape it, and then just set it on the table and hit the play button. That’s just awful for me... Yeah, it’s almost like I’ll just scribble stuff down. I don’t try to get down every word they say. And if I think what they are saying is very important, then I’ll start writing like mad and trying to get everything out.

However, Jay followed this with the fact that he seldom goes back to his notes to study, but the act of taking the notes is what is important. (80/81J.3.7)

His tactual ability and skill was highlighted when he spoke of times in lab situations where he would construct devices to meet specific needs for lab experiments. His use of more than one perceptual modality is again evident in this description.

I like making things. It's funny because, sometimes we don't have something for something in the lab, so I'll just make it out of, you know like. They call me the 'tinkerer,' something like that. Because if I need some-thing then I just look around and see what we've got that I can use and then kind of think about it and then make something. I needed a rack for, I was actually working with DNA this summer, and you have these small
tubes where you put the DNA in the top and it would drip through these beads that would bind it. And then liquid would drip out, but you have to have these tubes hanging and tubes underneath. We had no racks, or anything that would fit these things. So I took some styrofoam tube rack, flipped it upside down and punched holes in the bottom of it and then stuck pipette tips in it. And then took two box like things, that were plastic, so they were real stable, and set that down, and then set that on top of there. It was really stable. They (fellow lab researchers) thought that was pretty neat. (79J.3.7)

Jay’s Dunn LSI scores for perceptual modalities were: kinesthetic (60) and then, tactual (57). These were verified in member checking where Jay commented that although kinesthetic is his foremost perceptual preference, he has come to rely more often on visual and tactual experience since they are more frequently used in traditional teaching methods, especially in college courses. He also spoke of the time in medical school where he was trying to memorize and learn the various blood and urine ion concentrations and their significance to medical diagnosis. It was by reading the charts of actual patients in a hospital and speaking with those caring for these patients that the concentration levels and ranges finally made sense. The experience of being in a hospital setting, seeing the patients and their charts and seeing the information being used or referred to, where it finally became easy for Jay to learn this. Carl and Jay’s perceptual modality strengths are compared in Table 5.4. Note that they share the kinesthetic element as a strength.

5.2.6 Physiological Characteristics of Carl and Jay

The physiological elements other than the previously analyzed perceptual modalities include preferences for intake, time of day, and mobility. Intake is the preference for food or drinks while one is studying or concentrating on mental tasks. Time of day is a preference for one time of the day over others for which one is most able
<table>
<thead>
<tr>
<th></th>
<th>Carl</th>
<th></th>
<th>Jay</th>
</tr>
</thead>
<tbody>
<tr>
<td>auditory</td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>visual</td>
<td>I</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>tactual</td>
<td>I</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>kinesthetic</td>
<td></td>
<td>D</td>
<td>I</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.4: Perceptual Modality LS Elements of Carl and Jay

to concentrate and accomplish mental tasks. And mobility is the need for frequent
movement or motion when concentrating on learning tasks. For all learning styles
tasks, these and other elements are important when one is trying to learn new or
difficult information.

Carl did not indicate a need or preference for intake in responding to interview
questions. Having something to eat or drink for him while trying to study was re-
ported as being more of a distraction. He reported that he would take short breaks
when he felt the need to eat or drink and then return to his studying. (70C.3.5)

Jay responded in a similar way indicating that having something to eat or drink
while studying is more of a distraction than helpful. (55J.2.11) Neither Carl’s nor
Jay’s LSI profile indicated a preference for intake as part of their learning styles. Carl’s
score however, was a 59, which is very close to being an indication of a preference for
intake. Jay’s score was 53, which is not an important element of his learning style.
On interview items dealing with time of day, Carl reported a preference for completing mental tasks in the morning. He’d even schedule his most difficult undergraduate courses during the mornings. He responded that the earlier he has to get up in the morning the more quickly he wakes up. (51C.2.13) Carl reported that,

I’m a lot more focused in the morning. And, I’d rather take a test in the morning. I find that I’m a lot more focused in the morning than in the evening. I’m alert in the evening, certainly get a lot done, but the morning is my real time, is where I think that, if I were to really have to concentrate on something, I’d rather do it in the morning. (10C.1.3)

On the Dunn LSI Carl’s scores for time of day did not indicate a preference. The three scales for time of day were 48, 50, and 56 which indicates that time of day is not a crucial element of Carl’s learning style.

Jay’s responses to interview items regarding time of day preferences revealed that afternoons and evenings are the best studying times for him. He responded, “For studying probably afternoon and evenings I feel like I’m best able to study, especially if I’ve had some time to relax during the day. But in lab work, usually the morning is the best time for me there.” (61J.3.1)

In another place during the interviews Jay explained more completely his preferences for studying and performing mental tasks during different times of the day. His responses, however, were somewhat contradictory and must be interpreted along with other responses.

In the evening, I feel like I’m more easily distracted, but I’m more alert. So, it’s kind of a trade off for me. I always felt like there was never a key time for me, of the day, cause in the morning, I’m used to getting up and going to classes and what not. So in the morning I can wake up and really sit down and really work through things. And, I’m not usually motivated that much in the morning. But in the evening, I feel like I’m alert, and if I want to memorize or stuff like that, evenings or late hours of the morning, one or two in the morning, is my best time to memorize. I can be more
productive in the evenings work-wise, but I don’t think I’m as focused on work during the evening. It’s more a, ‘ok, it’s dinner time, it’s, what other kinds of things are going on tonight?’ There’s normally activities, community activities, things like that at night. I usually end up putting stuff off till evening, but I think the best time for me to actually sit down and work is in the morning, because I feel like there’s not anything, there’s nothing else going on, cause everyone’s working too. You know? So that kind of motivates me to work in the morning, because if I’m not working, well, what else is there to do? (13J.1.4)

As for the time Jay scheduled his most difficult classes:

...difficult classes in the morning. I think it’s for the reason that, if I’m going to have a difficult subject and what not, I can be alert in the morning. Once I’m awake in the morning, I’m kind of groggy, but once I get in the shower, it seems that my time to wake up in the morning is after I get out of the shower and then I’m ‘ok’ and then I go to my class. And I’d rather take that class and be working in the morning, than I would be in the afternoon, because it’s kind of like getting it out of the way, especially if it’s difficult and I’m really not enthusiastic about the subject. (14J.1.5)

Jay’s LSI profile scores for time of day indicated that he prefers afternoons (67) followed closely by a preference for evenings (40). This may indicate a flexibility in his time of day preferences.

In a more interesting note, Jay indicated that he had a unique sleep-study routine which he utilizes when he needs to accomplish a lot of studying or completing assignments. It was a strategy that his brother did not utilize or was not even aware of until mentioned following the first set of interviews.

Jay described his sleep-study routine in the following way.

I call it my sleep-study cycle. My favorite way to study is, what I’d like to do is, I’ll study that material, especially if you’re reading a book, and science books and things can get pretty dry. So I’ll read it for a while, and there’s only so long that I can concentrate on the material. The concentrating I do is really intense and then it almost wears you out mentally after a while, like after studying for quite a while. I kind of like
(makes ugh sound), ‘what did I just read?’ When I get to that point where I’ve just got to a paragraph and I can’t tell what I just read, or I have to go back through and start (over), I find my mind wandering, starting to wonder a little bit. ‘Ok, time to put it away, so I shut the book and I’ll actually just take a short nap, maybe a half hour. So I just go to sleep, wake up, and then start studying again, as long as I have, you know, food or whatever, I can do that for hours and hours on end. Just sleep, study, sleep, study, and it’s weird cause I won’t get the traditional seven hours of sleep. Whatever I sleep, if I’ll sleep-study, I can do that over a 24, or 48 hour cycle. Or I can go as long as I need. (9J.1.3)

Jay does not use this strategy for all his studying, just when he has much to accomplish in a short period of time or near deadlines. He mentioned in one of the member checking interviews that he had recently used the sleep-study cycle in the spring term of his first year of medical school. And he echoed many of the same remarks of the previous interviews.

Sometimes he may not even have to actually sleep between his study periods as the following quote explains.

I’ve actually kind of watched myself, to see what kind of sleep I going to get. If I’m not too exhausted from the studying, then I may not even fall into a sleep. I’ll just sit there and relax and rest my mind, almost like a meditation, just for about 10 to 15 minutes, and then I’ll get myself up and study again. But eventually I just sleep and actually I’m pretty try to the hour and a half. I find I generally sleep for maybe an hour and forty minutes. If I really go to sleep, it’s not like I’m going to wake up and, it’s not like people who take 30 (minute) power naps. I’ll wake up after an hour and a half. Or even sometimes I’ll even do a three hour, I don’t know, about that three hour thing. I’ll set an alarm to make sure I get up, but generally it’s for an hour and a half. (10J.1.3)

And Jay recalls what he’s been studying using such a sleep-study cycle strategy too. He also emphasized in member checking that he continued to use this sleep-study cycle during his first year in medical school. But Jay only resorts to it when he needs to learn a great deal of information in a short period of time.
<table>
<thead>
<tr>
<th></th>
<th>Carl</th>
<th>Jay</th>
</tr>
</thead>
<tbody>
<tr>
<td>intake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time of day</td>
<td>I+</td>
<td>I(unique sleep cycle) D(evening)</td>
</tr>
<tr>
<td>mobility</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.5: Physiological LS Elements (other than Perceptual Modalities) of Carl and Jay

In fact I find I, you hear these people say, ‘I studied eight straight hours,’ and then they don’t remember nearly as much as I did for maybe three hours of studying and three hours of napping. I can recall much, much better, with the break in between. I used to write papers that way too, in English 101. I’d write some, sleep, write some, sleep, and I would do very well on these papers. I feel like sleeping rests my mind and allows my mind, I think of it even before I go to sleep, I think of the material. So it’s kind of like a trick for me too. ‘Ok, let’s process this material while I’m sleeping.’ (12J.1.4)

Jay also mentioned that he sometimes is able to wake up on his own when using the sleep-study cycle, almost as if he had an internal alarm clock that kept on his sleep and study cycle. (12J.1.4)

The last physiological element analyzed in the interviews and on the Dunn LS Inventory was that of mobility. Neither Carl nor Jay responded positively to questions and situations where mobility was preferable. Their Dunn LS profiles indicated that neither demonstrated a preference for mobility when studying. Table 5.5 shows the physiological preferences, other than perceptual modalities, for Carl and Jay.
5.2.7 Global Versus Analytical Characteristics of Carl and Jay

The Dunn LS Profile and those having conducted research using the Dunn Model have realized certain patterns among the elements and the psychological stimuli, specifically global and analytic characteristics. From these characteristics, it is possible to determine the degree of one’s preference for processing information either analytically or globally. As explained in chapter two, and listed in the table (3.2) the elements and their preferences correspond to global or analytic characteristics. These characteristics as well as, participant responses to interview questions were used to determine the magnitude of analytic or global processing. Interview participants were also given a grounded survey that provided a third method of assessing these characteristics.

Carl’s responses to interview items and situations indicated that he had a slight preference for processing information globally rather than analytically. He prefers having major concepts presented before dealing with the details, yet is very application oriented. At one point he commented, “I’m very much into how is this going to work in the real world. And so, when professors give, they do this (tell application based stories), that’s gold. I love that.” (33C.2.7)

And again, he stated,

I’m really big on analogies. I’m really big on ‘big picture’ type things...I like to use a lot of analogies, lot of stories, with something totally unrelated, like a steering wheel when you’re learning stereochemistry. That type of thing.
In teaching others, he stated, "I start with the big picture and I go into the details but then frequently I go back to the big picture so they know that I'm big on 'in context' type things." (25C.2.4)

Carl's responses to the global - analytic survey indicated that he was slightly more global than analytic, but not extreme in either of his preferences or choices. Likewise, his Dunn LSI profile did not indicate a preference for elements that would be indicators of global or analytic processors. Carl is therefore flexible in the way he is able to draw upon either characteristics as the situation may demand.

Jay's global and analytic characteristics for the interview items revealed that he too was slightly more global than analytic. Some of his comments reflect those expressed by his brother. In discussing the way in which Jay would approach a problem or explanation, either by working on his own or in relating information to others, he said the following.

I like to do both. (have main ideas and details). Give an overview so they can kind of understand, and then you give them the details. I find sometimes you get so bogged down in the details that, what's important for me, I think is the overall picture. I mean, I'm really a big picture (much emphasis on 'big picture') kind of guy. (34J.2.4)

Again, Jay explained a similar sentiment:

I'd say I'm more of a 'big picture' kind of person. I do get into the details, and you do 'muck' through them, but the first thing I try to see when I get something, is the big picture. And I think that's more me. I like to see; I like it so much, the big picture's always the most important thing, I think. (42J.2.7)

Jay's responses on the global - analytic survey revealed that he was slightly more analytic than global. And his Dunn LSI profile had only one element that corresponded to global processing. That element was his preference for informal design.
<table>
<thead>
<tr>
<th></th>
<th>Carl</th>
<th>Jay</th>
</tr>
</thead>
<tbody>
<tr>
<td>global</td>
<td>I (slightly)</td>
<td>I (slightly)</td>
</tr>
<tr>
<td>analytic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.6: Psychological LS Elements of Carl and Jay

This information could be interpreted and taken as evidence that Jay does not have a strong preference for either global or analytic processing strategies, but rather utilizes both as situations may dictate. The psychological elements for Carl and Jay are shown in Table 5.6

5.3 Ann and Jill

Ann and Jill grew up in a medium-size, Midwestern town and attended a parochial elementary and secondary school. They both spoke candidly about the expectations their parents, their teachers, and the parochial community had regarding education and preparation for college. Early in their education however, Ann and Jill became interested in different subjects and content areas. Both did enter college and received bachelor degrees. Ann’s was in audio engineering, and Jill’s was in health and physical recreation. Both also returned to graduate school to pursue advanced degrees, Jill completed her doctorate degree in exercise physiology and health. Ann is enrolled in
a graduate program and pursuing a master's degree in natural resources. Each commented in the interviews that they considered themselves to have distinctly different ways of looking at situations and problem solving.

5.3.1 Environmental Characteristics of Ann and Jill

Among the environmental elements, Ann expressed a preference for quiet when studying. She said she can not tune out sounds in the background and that the presence of such sounds makes it “difficult to concentrate.” (1A.1.1) Her Dunn LSI profile, however; did not indicate a preference for quiet, having recorded a score of 43 for sound. Jill, on the contrary, expressed her acceptance of sound as usually a part of her study environment. Her responses to interview questions did not make sound essential for her to concentrate, but it was her preference. Jill’s LSI profile revealed that indeed sound was an essential element of her learning style. Her score for sound was 62.

On the condition of lighting in her study area, Ann responded that she’d prefer more light than less. However, it was not a major point discussed in many of her responses when asked to describe her optimal study area. Her LSI score for light was 54, indicating that lighting is not a major consideration for Ann’s learning style. Jill expressed a preference for dim or shaded light when studying, but did not emphasize this in all of her descriptions of her study environment. Jill’s LSI profile however, indicated that she has a preference for low light conditions when studying. Her score was 35.

When the environmental element of temperature was discussed in the interviews, Ann responded that she prefers to have the temperature warmer than cooler when
trying to learn material. She responded: “I usually want the room to be warmer. But I’m cold all the time. That’s distracting to me, if I’m cold. If I’m cold I’m more uncomfortable and I’m not going to be able to really concentrate.” She continued, when “people are comfortable, and I’m a little too cold.” It’s not always the case, but she said it was that way more often than not. (3A.1.1) The Dunn LSI profile did indicate that temperature was a major factor in Ann’s learning style, having a score of 65, indicating that Ann prefers a warm study environment.

Jill too, expressed a preference for warmer temperatures indicating that she often gets cold easily, and dislikes feeling cool. The Dunn LSI profile also verified that Jill has a preference for warmer temperatures when studying. Her score on that subscale was a 65.

The fourth environmental element of design was one of close agreement. Both Ann and Jill indicated in various places in their interviews that they would and do create informal study environments for themselves. However, they also spoke clearly of the times when a formal study area would be necessary and desirable. This element appears to be one where they each are flexible, showing no extreme preference. Their LS profiles reflected this as well: Ann’s score for design was 43, and Jill’s score for design was 41. Table 5.7 compares the environmental elements of Ann and Jill.

5.3.2 Emotional Characteristics of Ann and Jill

Both Ann and Jill are very motivated learners who find their desire to learn to be more internal than external. They were not driven by grades, nor by the need to please parents or those in authority. However, they each did discuss extensively the role of parental, school, and community expectations had on them as learners. They
<table>
<thead>
<tr>
<th>Sound:</th>
<th>Ann</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I (quiet)</td>
<td>D (sound)</td>
</tr>
<tr>
<td>Light:</td>
<td></td>
<td>D (dim)</td>
</tr>
<tr>
<td>Temperature:</td>
<td>I+ (warm)</td>
<td>D (warm)</td>
</tr>
<tr>
<td>Design:</td>
<td>I+ (warm)</td>
<td>D (warm)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LS/Profile
Description given in parenthesis

Table 5.7: Environmental LS Elements of Ann and Jill

thought that it was expected that they would do well in school and excel in academics and eventually go on to college. There really were not too many other alternatives.

At one point Jill remarked,

I don’t ever remember thinking that it was an option not to go to college. Everybody I went to high school with was really taking courses preparing you for college. So I remember, until I got older, I met people that never went to college. Wow, I never even thought that there were choices other than that. It just never even dawned on me. (5Ji.1.2)

Jill explained the sense of expectations in her early educational experiences:

I think more than anything, just a sense of expectation, it was just expected of me to be a, to master certain things or take certain classes, and to do well. It was never, a question of having an opportunity to fail, or to not be able to be expected to do it...I don’t remember my parents being involved. My father was always available to help, but they didn’t stand over us, and make us do our work. It was more just, you were expected to do it, so you did it. I don’t ever remember thinking, an option of not doing it. (6Ji.1.2)

Ann reflected similar ideas in discussing her family and school experiences while growing up. She too, mentioned an awareness of certain expectations held by her parents and teachers.
Well, it’s kind of like growing up in a family where there are certain expectations. The whole environment there, is very, I think they give you more responsibility but because of that, you achieve more. Because, they don’t necessarily call on you, or beat you over the head, you have to, I guess there are certain, expectations, to achieve academically. And I don’t really remember the teachers, being, so intense about it, beating it into us, you just knew that that was what was expected of you. And everybody was kind of on that level. If you lagged behind, or you ‘schlepped off’ on your work, you definitely would have been ‘put out.’ (13A.1.4)

Jill and Ann also expressed the idea that they are more motivated to learn new information if they are interested in that material. And although they are curious about the world, they have times when they find it rather difficult to be motivated. Ann also said she has a tendency to procrastinate at times. So on motivation as part of their learning styles, both indicated that it would not be a major element. They were, however; both highly motivated young women who find more of a need to learn for their own sake or interest than to achieve some end goal or outward reward. Ann’s score on the LSI profile for motivation was 42, while Jill’s was 47. These scores would not indicate they are very flexible when it comes to the value of motivation and their academic achievement.

The next two emotional elements, persistence and responsibility, were ones where neither Ann nor Jill expressed strong preferences. But each did express similar attitudes. For example, in college group project situations each expressed their tendency to be the one who would be persistent about assigning specific jobs to people in the group. Ann and Jill also said they would most likely take on the responsibility of writing up the final draft of the group work, and collecting contributions from others in the group.
Both Ann and Jill also had extensive examples and comments on the issue of responsibility in learning. Ann stated:

I think just in general I'm very responsible. I'm conscientious about getting things done on time. And, like I think more of group project situations, you know how they're some people who take responsibility for it and other people that kind of just follow along. I think, at least in my recent memory, I was much more comfortable saying, 'I'll take care of this, either writing it, you guys just give me all the information.' Or just seeing that it's done well, because I trust myself more than I trust (other people) even though it's a burden because you take on all this, and I don't have time to do this. It's usually less stressful because you know you're going to get it done right. (11A.1.4)

Jill reflected her sense of responsibility in group learning situations too. “Definitely if you have to collect, and rely on someone for something to do the work you need to do, then it's limiting and, I would rather just do the whole thing myself.” In group learning situations and in dedication to group assignments, Jill commented that, “I guess I would say I would be more motivated, I probably would do it more thoroughly.” (11Ji.1.3) She is also one to urge others in group learning situations that, “this is what we need to do, now do it. Regardless of if people enjoy, or seeing an option of not doing it.” (12Ji.1.3)

Again Ann responds to the question of responsibility in high school experiences:

I don’t remember if I ever really (was) being bullied by my parents. I mean we were really good students, and there were certain expectations, so I think I grew up understanding that that was my responsibility, to get your work done, try to do well on your exams. I just remember that that was part of our structure, of our schedule for the day, you got your work done. (12A.1.4)

Ann thought of herself as having being a very responsible person in learning situations. In responding to who Ann felt most responsible to, she responded:
I kind of want to say the instructor. It really depends, I guess? When I think of an academic setting, I want to say, most of it is myself, but I think it depends on the structure. If it's something that I'm interested in, then, but you really can't say that about the majority of the courses I have to take. (39A.2.7)

Ann's answers to questions of persistence and responsibility did not reflect a definite pattern but appeared to be situational and conditional. Her Dunn LSI profile for those elements reflect this as well. Her scores for persistence and responsibility were both 56, another middle score that indicated flexibility.

Some of Jill's responses to questions of responsibility deserve mention here as well. She stated,

I think I tend to be very responsible for things that I agree to do, not necessarily for things someone else expects me to do (emphasis on 'expects'). But if it's a task that I'm willing to accept or accept what they say, I'll do it. I feel pretty responsible getting it done and doing it well, getting it done on time. (29Ji.2.2)

Jill explained who she feels most responsible to in academic or learning situations. "I would say myself. More than, more than a professor..." (29Ji.2.2)

Ann expressed her persistence as being somewhat dependent upon how practical the learning experience.

If I go back to this engineering mentality of problem solving, yes, I think, like figuring out the solution to a problem, I was persistent. But if it's something more theoretical, and it doesn't make sense to me, it's easier for me to put that off, and consider it as 'not important.' So normally I wouldn't be that persistent. But if it's something practical. (8/9A.1.3)

On the Dunn LSI profile for persistence, Ann and Jill scored with in the flexible range and did not show extreme preferences. Ann's score was 56 and Jill's was 53. On the element of responsibility, each scored within the flexible range: Ann's score was 56, Jill's score was 52.
The final emotional element analyzed was that of structure. Here there were some dramatic differences in the approaches of Ann and Jill. But there were also some interesting parallels in how each would organize their learning tasks and their study time.

Ann’s responses included the following excerpts:

I do much better with structure. If I’m in a situation where this has to be completed by this time, rather than just open-ended working on a project where, unstructured. (7A.1.2)

...Yeah, I enjoy, like making lists. I always have a list of what needs to be done, what still needs to be completed, whether it’s, I always make outlines. I like to be able to see everything in front of me that needs to be done, and then kind of methodically check it off, as it gets done. And I definitely do much better in situations where the structure of the assignment is such that the outline has to be turned in by this day, and then the first draft has to be turned in by this day, these chapters have to be read by this day. (14A.1.5)

On preparing to being an assignment, Ann responded:

Well, I’d say I try to gather everything I think I’m going to need before I actually sit down. I feel like, it’s hard for me to get into that mode, once I’m there I want to make sure that I can stay there. I don’t want to get started on it if I’m only going to have thirty minutes to look at it. Or if I’m there and I’m going to have to get up and, go to the library or whatever. I’d definitely would rather have everything there, cause once I get started, I just go. (14/15A.1.5)

Jill’s responses to the need for structure indicate that she tries to use structure in planning study time, but does not use lists and outlines as much as Ann. Some of her comments included the following. Notice that her attempts to set up her study environment parallel those of Anu’s.

On making and using structure strategies such as lists and outlines, Jill responded: “I’m big on making them, I don’t know how well I follow them. Yeah, that tends to
<table>
<thead>
<tr>
<th></th>
<th>Ann</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td>motivation</td>
<td>I(expectations)</td>
<td>I(expectations)</td>
</tr>
<tr>
<td>persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>responsibility</td>
<td>I(group work)</td>
<td>I(group work)</td>
</tr>
<tr>
<td>structure</td>
<td>I(organize tasks)</td>
<td>D(prefers)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.8: Emotional LS Elements of Ann and Jill

help me, conceptualize how much, that I need to get done, kind of prioritize." She continued to say that she does not use a calendar or day planner, but does sometimes use a legal pad for planning. (10Ji.1.3)

Most likely, I would have to have, I would have to know how much time that I have, a block of time, I don’t usually like to get started on things, if I know I don’t have an hour or two. Usually if I had a big paper to write, or project, I would try to get everything done, on Saturday, and then know that as soon as I got up Sunday morning I was going to start working on it and wouldn’t do anything else, until I finish it. I’d get other stuff, little stuff done and out of the way, so I wouldn’t have any distractions of things I needed to do, and then just starting in when I had a big block of time. (9Ji.1.3)

On their Dunn LSI profiles for the element structure, Ann showed a preference for structure with a score of 67. Jill did not show such a preference, with a score of 44. Table 5.8 compares the emotional elements of Ann and Jill.

5.3.3 Social Characteristics of Ann and Jill

The preference to work alone was clear for Ann and Jill. Their interview statements and stories revealed some interesting situations where they had preferred to
work at learning tasks by themselves. At several times they shared similar ideas regarding group or paired situations in their graduate courses.

Some of Ann’s remarks follow.

My first inclination would, is to say, I’d rather be someplace alone, where it’s quiet, where I’m in control of people coming or going, or noise. But then, I can think of times when there are very difficult things where it was nice to have a classmate or something to work through things together. I would never study with a large group, but maybe one other person, to gain perspective from. Or someone who could understand different aspects of how something’s put together. (16A.2.1)

Ann explained the process of how she would typically try to learn something on her own first, before approaching others.

My first instinct is that I should be able to figure this out.... A while ago I was taking a computer programming class, which is something that I never did before, and, it was really difficult, but I was really challenged to figure it out.... I work at it, just, I would ask other people in the class, ask the lab monitors,.. but my first inclination is to like go someplace quiet and read it, or go through it step by step with the class notes or revisit the class notes. Try to figure it out, and then try to apply it, and then if I’m still having problems with it, go and seek help. (37/38A.2.7)

Ann continued on to explain more about the qualities of other person she would like to work with in learning situations.

Actually I’d rather have them be a peer. Someone in my class or someone who took the class the previous quarter, the previous year. I think it’s almost easier, cause you’re on the same level, and you can relate to what you’re struggling with. I found sometimes when you try to ask a professor, or somebody that’s much more knowledgeable, it’s so much harder to communicate what it is that you need to know. (17A.2.1)

When asked about her study - social groupings when she was younger, such as in elementary or in high school, Ann responded: “my recollections of studying as a younger child, it was mostly by myself.” Ann and Jill did not study together in
elementary or secondary school. Ann also commented that it's often more distracting than helpful to have to work with others in learning situations.

Jill's comments and responses to interview questions echoed some of the same ideas as Ann's responses. In responding to whether Jill would prefer to work alone or with others on learning tasks, Jill responded as follows.

I would say overall, alone. In terms of, yeah. If we got together to have a review session after the fact, that was fine, but if it was initially starting a project or starting to do the work, I'd like to be alone.... Definitely if you have to collect, and rely on someone for something to do the work you need to do, then it's limiting and, I would rather just do the whole thing myself. (11Ji.1.3)

Of course some of Jill's references appear to refer to group work in general and not in learning specifically new and difficult information.

Jill too, said there were times when she could work well with another person.

I guess it would depend on who it was, but yeah. There are people, I've found who I can work well with, then again, it usually ends up being a situation where the parts that we're contributing need to be clearly delineated, brought together, rather than back and forth collaboration.... If it's a situation where you have to read and synthesize some kind of event or write a paper, I'd rather be left alone. (13Ji.1.4)

In one case Jill explained how she felt about asking Ann for help on homework assignments when they were younger. She said,

I remember even with Ann I would like not even go to her, and when I would ask her to help me, I'd go, 'that's not right.' And I'd still ask my dad. I trusted adults more than other kids cause I'd think, 'why would they know more than me'? (14Ji.1.4)

Ann reflected a similar sentiment when she said she was never really tempted to cheat or look on the papers of other students in elementary and secondary school, having more faith in her own ability and knowledge than in that of her peers.
<table>
<thead>
<tr>
<th>self</th>
<th>Ann</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td>group</td>
<td>I(difficult)</td>
<td>I(difficult)</td>
</tr>
<tr>
<td>authority figures</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LS1 Profile  
Description given in parenthesis

Table 5.9: Social LS Elements of Ann and Jill

Ann’s and Jill’s LSI individual profiles indicated that social conditions are not a major influence or consideration of either of their learning styles. Their scores for social scales, including working alone or with peers and the presence of an authority figure, were all in the midrange or flexible area of the profile. This would tend to indicate that although they do have definite preferences for working alone in learning situations, the social stimuli category is not a major influence on their learning ability or level of concentration. Table 5.9 shows that while Ann and Jill gave similar responses to interview items for social elements, they did not show such strengths on their Dunn LS profiles.

5.3.4 Perceptual Modality Preferences of Ann

The perceptual modalities of Ann and Jill were perhaps the elements of greatest difference. Ann’s responses in the interviews stressed her preferences for visual and tactual experiences. Jill’s responses reflected her preference for auditory experiences. And although both of these young women have always been involved in sports and exercise, kinesthetic perceptual strengths were not emphasized, as might be expected.
Ann’s perceptual preferences included many references to visual and tactual learning experiences in both academic and work related situations. In lecture situations she stressed the value of visual at first, but later said a combination of perceptual modalities might be best for her.

I would tend to say pictures and graphs, but then I think back to some classes recently where, a graph didn’t mean anything. I do think a combination of all those things. I wouldn’t lean so much toward the demonstration... But I know at work, I would much prefer ‘let me try and you watch, and tell me, how I can do it much better. (21/22A.2.2)

Actually what I like to do, depending on the class it is, I’ll write down as much as I can, during the class period. I like to go home and, sometime in the next day or few days, depending if I have time, maybe the weekend, and rewrite them. Just so I can kind of fill in the, maybe if they’re not filled in completely, and that gives me another, more of a, actually processes it and retains it, instead of just trying to get it down on paper. I don’t know if I always did that, but I know, especially in grad school I did that a lot. (24/25A.2.3)

Ann commented that she’s more likely to take notes than highlight, although she does highlight her notes. She never highlights in books, mainly because she just never associated that technique in books as being different.

Ann also commented that during her intense periods of concentration she is often moving an arm or leg unconsciously, although she didn’t think it was a sign of her kinesthetic preferences and indeed never associated it with helping her concentrate.

Ann typically goes through her notes in preparation for tests and quizzes at least three times. She also described the role of reading in preparation for such evaluations.

I would get caught up on any reading that I knew was going to be covered in the textbook that I hadn’t finished yet, to make sure, I just read everything through once. And then, take notes if there are things in there that I really wanted to be sure to focus on. And then, generally what I’ll do is go back and review my notes and any handouts that were given out in class. I usually, the system that’s always worked for me, is go through
everything, not trying to learn it all, but just to get an overview, every page once, more than just scanning it but not stressed out and worried that I'm thinking 'God, I don't know that yet.' Just making sure that I've seen it all once. Then I'll go back the second time and pick up some of the things I'm not clear on, and if I get to things I'm not clear on, then spend a little more time on that, to get a real thorough, making sure I understand it all. Then right before the test I'll go back the third time and just do a brief look over, and touch on the stuff that I highlighted.

(59/60A.3.3)

Ann's responses to the grounded survey items embedded in the interview indicated that she had a slight preference for visual and visual-tactual experiences. Her Dunn LSI profile results indicated a visual preference as her strongest perceptual modality although it's score was 55, and not considered a very obvious preference over the kinesthetic and tactual preferences. It was however, much stronger than her lowest preference which on the Dunn LSI profile was auditory.

During one of the member checks, Ann explained:

I believe this 'inconsistency' may be the result of me considering different learning situations when answering these questions. Most of the 'new' learning I do these days is at work where tasks are typically very technical and often mechanical in nature. In that case I would prefer a more tactual presentation of the information. Whereas, in an academic setting, especially when new information is often times more theoretical in nature, I would definitely prefer visual learning. (Member Check/A.1)

5.3.5 Perceptual Modality Preferences of Jill

Jill’s responses to perceptual modality questions and situations in the interviews were as follows. She would try to learn or remember important information in the following ways. She said “I would say, for the most part just saying it to myself, maybe writing it down.” She continued to explain,

I took notes but they were, never really read them that much. And I think as I got older, I took less and less, cause I realized I got more out of it just listening, than trying to write everything down. (16Ji.1.4)
She also explained that if someone tells her something, and she hears it clearly, there’s a good chance she’ll remember what was said. “I’ll remember it for years, once I’ve heard it. That used to bug my friend, I’ll say ‘no, you said...’ I can remember it much more than if I see it.” (16Ji.1.4)

Jill too, explained that even while concentrating and studying, she is hardly ever sitting completely still. A similar response to that of Ann’s.

Jill furthermore, explained the importance of having a lecturer use the correct words to convey ideas and to get concepts across. She finds words more helpful than pictures to communicate most ideas. (23Ji.1.6) Again she emphasized that over the years, especially in her graduate courses, she’s benefited less by taking notes and more by listening attentively in learning situations. (58Ji.3.4) Jill’s preference for auditorily receiving information in learning situations became clearer as the interviews progressed.

Jill’s responses to the embedded survey confirmed her reliance and preference for auditory, but also for visual experiences. And Jill’s Dunn LSI profile revealed that her strongest perceptual modality among the four was definitely auditory. Her auditory score however, being a 55, would not be considered extremely strong. Her lowest score among the modalities on her profile was for tactual.

In an interesting side note to one of the interviews, both remarked that they sometimes have difficulty communicating with each other. This appeared to be related, at least in part, to their differences in their perceptual modalities. Ann explained how easy it is to get Jill to understand something she’s explaining:

...actually, with us, it’s not that easy. We think very differently, we process things differently. It seems the older we get the greater that difference is. I don’t remember butting heads about it so much as kids, but we really just
see things very differently. We have different priorities, different interests, and so, we go round and round. (67A.3.5)

Jill echoed the same idea, and gave a little more of an example of one of the times they did not communicate clearly.

I think if anything, I think Ann and I don’t communicate because we’re so different. We’ve had weird situations where we’ve had similar experiences and the same dreams, and things like that... We’re so, if anything, we’re the opposite of that... We just communicate so differently, and I think we’ve gotten to the point that, we probably assume too much of what the other one’s saying or doing, or what they’re going to do, and it ends up creating a friction, rather than easing communication. Cause she just automatically thinks that everything I do, I do to antagonize her, or make her life harder. And the, just to go against, or do the opposite of what it is that she wants to do. Ah, and I feel like she sets me up, by not giving me all the information. You know, she’ll say, ‘Well, what are you thinking about? How is this going to work tomorrow? What are we going to do tonight?’ ‘Oh, I don’t know, I was kind of thinking we’d play it by ear, and go whenever.’ And then she’ll go, and start with, ‘Well, don’t you know, that we have to be there by such and such a time?’ Instead of giving me that information ahead of time, and then say, ‘How do you want to do it?’ And it puts me on the spot and then, like criticizes me for it, yeah, gets mad because I didn’t come up with the plan that she had. We approach things very differently. (67Ji.3.6)

Ann and Jill’s perceptual modality strengths are shown in Table 5.10. Note that they are not similar.

5.3.6 Physiological Characteristics of Ann and Jill

On the element of intake, Ann commented in the interviews that although she does often have a snack or drink while studying, it is not necessarily associated with her ability to concentrate. She also commented that it was not a pattern in elementary or secondary school.
<table>
<thead>
<tr>
<th></th>
<th>Ann</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td>auditory</td>
<td>I+</td>
<td>D*(55)</td>
</tr>
<tr>
<td>visual</td>
<td>I+(at school)</td>
<td>D*(55)</td>
</tr>
<tr>
<td>tactual</td>
<td>I+(at work)</td>
<td></td>
</tr>
<tr>
<td>kinesthetic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis  
D* = Strongest preference shown, even though it's not >60

Table 5.10: Perceptual Modality LS Elements of Ann and Jill

Jill’s comments were that while she too often has something to eat or drink while studying, it is not a major factor affecting her ability to learn new or difficult material. It is more a matter of “the convenience of being able to get something, and I usually, I never just eat. I’m always reading a book or doing something else. So it certainly doesn’t, it’s not like I stop what I’m doing” (just to eat). (41Ji.2.4) She emphasize the efficient use of time, especially since she also commented that she’s “not a big eater,” anyway, so snacks are not that important to her. (58Ji.3.4)

On their Dunn LSI profiles Ann and Jill both had scores within the mid-range, 51 and 50 respectively. Such scores indicate that intake is not a major element of either Ann’s or Jill’s learning style.

On the physiological element of time of day, Ann expressed a preference in the interviews for evenings, late evenings from 9 or 10 pm on. And in one of the follow-up member checks she clarified that even later in the evening is probably even more preferable for her. “I feel I concentrate best later into the night, say 9 pm - midnight.”
(MC.A.7) Ann’s LSI profile reflected a preference for evenings, a score of 35, which is a strong preference.

Jill’s interview comments reflected her preference for studying either in the morning or in the evening. She explained that she prefers to study, “first thing in the morning or late at night. Like from ten at night until two in the morning, or if I get up, first thing in the morning, seven or eight then I’m good for a few hours.” (20Ji.1.5) She also mentioned how her schedule for work or chores might dictate a difference in her study times on weekdays and weekends. She also mentioned that as a researcher she would prefer to do her work in the evenings. (43Ji.2.5)

Jill’s LSI profile indicated that her preference for time of day was late morning, a score of 65, and evenings, a score of 40. The profile indicates a slightly stronger preference for late morning than evenings and her interview statements reflected a similar preference for mornings and evenings.

On the physiological element of mobility, both Ann and Jill responded that they noticed the tendency to move an arm or leg, or hand when concentrating deeply. Neither associated such movements to helping them concentrate, although they were aware of their frequent movements. Ann’s LSI profile revealed that mobility was an important part of her learning style, a numerical score of 65. Jill’s LSI profile did not indicate that mobility was as important for her learning style; however, her score was 59 and very close the cut-off point usually indicating a strong preference. Jill commented in the interviews that she was often aware of her need for frequent movement, and was often viewed as being very “fidgety.” Table 5.11 shows their physiological elements, excluding their perceptual modality preferences.
<table>
<thead>
<tr>
<th>Intake</th>
<th>Ann</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of day</td>
<td>I (not mornings)</td>
<td>D (evening/afternoon)</td>
</tr>
<tr>
<td>Mobility</td>
<td>I (wants)</td>
<td>D (prefers)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.11: Physiological LS Elements (other than Perceptual Modalities) of Ann and Jill

5.3.7 Global Versus Analytic Characteristics of Ann and Jill

Of the interview items assessing the global and analytic processing preferences, there were some interesting similarities and differences among Ann and Jill. Ann’s responses in the interviews were more analytical than Jill’s. Ann remarked, “I think I tend to lean towards needing or wanting too much detail. I’m more detail oriented.” Ann said that in part it is consistent with her engineering background, “wanting to cover all the bases and to know, to know about the situation before you try to solve the problem. Yeah, that probably would be why I went into engineering to begin with. It looks that way.” (31A.2.4)

Ann explained that her studies in the graduate school of natural resources are, ...
much more of a challenge for me because it is, what I would call vague sometimes. There are less concrete, and correct answers, more gray area, much less structure than in the academic end of it…. It doesn’t bother me so much, but, I don’t know how to put it. It’s harder for me to stay focused, I guess, sometimes; or to complete tasks, everything just seems so theoretical and kind of unstructured. (31A.2.4)
<table>
<thead>
<tr>
<th></th>
<th>Ann</th>
<th>Jill</th>
</tr>
</thead>
<tbody>
<tr>
<td>global</td>
<td></td>
<td></td>
</tr>
<tr>
<td>analytic</td>
<td>I(slightly)</td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.12: Psychological LS Elements of Ann and Jill

Finally, Ann also expressed her preference to proceed with learning tasks in a “pretty much step by step, like if I had a grasp of what the task was, I would probably make an outline of how to go about, tackling it.” (31A.2.4) Ann also commented that working on her thesis for her master’s degree has been rather challenging because it is a rather ambiguous and unstructured task.

Jill’s responses stressed the importance of knowing the ultimate goal or objective in a learning situation, and then being more systematic about working towards that objective. Her responses indicated a preference a slight preference for global processing strategies.

On the grounded survey of global and analytic preferences, Ann and Jill responded very similarly to five statements. Jill’s responded to one more that Ann did not select. However, of those five, they were not indicating a clear preference for analytic or global characteristics. Considering their Dunn LSI profiles, neither Ann nor Jill demonstrated a strong preference for global or analytic processing characteristics, as shown in Table 5.12.
5.4 John and Jeff

John and Jeff were monozygotic twins studying nursing at a nursing school affiliated with a Midwestern hospital. They had both been familiar with the hospital environment since their youth. Their mother was employed at the same hospital and they had positive experiences visiting her when they were growing up, and having the opportunity to see much of what transpires in the course of a day in a hospital. John and Jeff both decided to pursue nursing as a profession partly because it was challenging, and each day was different. But they had each also mentioned plans of working, at least part time, with either the fire department or as emergency medical technicians on a rescue squad. Both enjoyed the excitement and varied opportunity that nursing affords.

5.4.1 Environmental Characteristics of John and Jeff

The responses to interview items covering the environmental element of sound for John indicated that John prefers to have some sound in the background, usually a soft playing radio, when studying. Jeff indicated the same conditions of background sound when he studies. However, neither indicated that it was essential to their level of concentration. Both mentioned that if they have the radio playing it is very softly and not intrusive. John mentioned the following scenario which occurred on several occasions when he was attempting to study in his study area in the basement of his home.

For example, we have a treadmill in our basement, where I do my homework. My sister and my mom would come down and get on the treadmill. I’ll stop and let them do the treadmill, and then come back when they’re done. (36Jo.2.2)
Sometimes John would go to his bedroom during that time and continue his studying there until his sister or mom were finished using the treadmill and then return to his desk in the basement. His brother’s study area in the attic of their home.

The LSI profiles for John and Jeff indicated that the element of sound was not a significant element for their learning styles. John’s score on this element was 50, while Jeff’s was 58. Jeff’s score was closer to the line and significant mark of 60, where sound could be more of a factor for him when studying.

On the element of light, John commented that in the room where he does most of his studying, he has the lighting very low, with one lamp over his desk. He expressed his dislike for bright lighting conditions. (3Jo.1.1; 7Jo.1.2) Jeff also expressed in the interviews that he studies in a room under low lighting conditions and with the lamp over his desk set on “low.” (7Je.1.2) They each expressed a dislike for fluorescent lighting.

Their Dunn LSI profiles revealed that John has a preference for dim lighting conditions, a score of 35, while lighting is not an important element for Jeff.

For the environmental element of temperature, neither John nor Jeff indicated that it was extremely important, except in cases where they were uncomfortably warm. John noted that he has a fan near his desk where he does most of his studying and when necessary uses it. (5Jo.1.2) Jeff expressed a similar sentiment when he described that,

If I’m hot at all, or warm, I can’t concentrate at all. I have to be cool. Like one time at my girlfriend’s house it was so hot, I was just ’burning up,’ so we came back to my house, took a shower, and studied where it’d be nice and cool. I can’t concentrate when it’s hot. (5Je.1.2)
The LSI profiles for both John and Jeff did not indicate that temperature was a significant element of their learning styles. In the interviews the importance of temperature when studying was mentioned on only one occasion in each of their respective interviews. John’s profile score for this element was 41; Jeff’s was 45.

The element of design was discussed in the interviews, and both said an important place to study for each was at a desk and chair. John had his study area set up in the basement, while Jeff had his in the attic, where he had his “office” arranged in a corner of his bedroom. It was mentioned by each young man that having a large uncluttered desk on which to work was important. John mentioned that besides using his desk, he would occasionally read while laying on his bed.

If I read, stuff I’ve got to read, laying down. If I’m reading, I’m usually in my room, on the bed. But if I’m studying, I’m at the desk. Or if I’m taking notes, I’m at the desk. Usually when I’m reading, I’m on my bed. (37Jo.2.2)

Jeff commented that he works at his desk and doesn’t lay down when studying or when reading material. (3Je.1.1)

Their LSI profiles indicated that design is not an important element of either of their learning styles. John’s score was 43, while Jeff’s was 50. Both scores were in the mid-section, or flexible region of the Dunn LSI profile results. Their environmental elements are summarized in Table 5.13

5.4.2 Emotional Characteristics of John and Jeff

Both John and Jeff are motivated learners, as well as, motivated to excel in sport activities. They considered themselves to be more motivated at learning tasks in their nursing education than in high school, largely because they considered the preparation
<table>
<thead>
<tr>
<th></th>
<th>John</th>
<th>Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light:</td>
<td>I(dim)</td>
<td>D(dim)</td>
</tr>
<tr>
<td>Temperature:</td>
<td>I(cool)</td>
<td>I(cool)</td>
</tr>
<tr>
<td>Design:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.13: Environmental LS Elements of John and Jeff

for their profession to be more relevant and meaningful. John expressed the idea that he’s more motivated since this is going to be his life’s work.

My career, I think. I don’t know. (pause) if I’m going to do something, like I’m going to be a nurse, I’m going to be the best that I can be.” He also said that he can tell other nurses who are very competent in their jobs and he said, “I look up to the one’s that are real good at their job, and I want to be looked at (that way), I guess. (10Jo.1.2)

John continued,

I want to be respected as a nurse, but for myself I want to, make use of things I know. If I don’t know something, I feel guilty, about myself. I want to know stuff, for myself, just so I know. I want to be as good as I can. (10Jo.1.2)

He applied this same philosophy to his high school wrestling competitions.

John mentioned that he was considered to be ‘self-motivated’ by others who know him well. “Yeah, people say that about me. I put in near 110 percent. I figure if you’re going to do it, you might as well do it as best you can. If you go half, why do it?” (16Jo.1.4)
Jeff responded to the question of what serves as motivation for him as a learner by saying, “self-fulfillment, to know that I learned something for myself, and did it right. I know and understand the whole concept of what I’m learning, that I did it myself.” (8Je.1.2)

He too, drew parallels to his wrestling in high school and the fact that he prefers individual competition to team sports when given the choice. (11Je.1.3)

Although both John and Jeff are highly motivated individuals in many regards (sports, their comparison of grades, and in their hobbies), they did not always exhibit strong motivation in academic matters prior to enrolling in college courses. Their Dunn LSI profiles indicated that motivation was not a strong or obvious element of their learning styles. Both profiles revealed a score of 57, which is toward the motivated end.

On the element of persistence in their learning, the interview questions revealed that both John and Jeff were persistent, but more so in sports than in academics. Again, there were instances when they spoke of times when they were persistent in their pursuit of academics in their college nursing courses, but more so, it was instances of persistence in their competitive sports. The Dunn LSI profiles did indicate that persistence for Jeff was a major part of his learning style (64), while the persistence score for John was in the center, the more flexible range, with a numeric value of 56.

The element of responsibility or that which is often called “conformity” proved to be an element where John and Jeff differed. John’s responses to the items involving responsibility and conformity were brief, with references to how others considered him to be responsible. While Jeff’s responses were more elaborate. Jeff mentioned
<table>
<thead>
<tr>
<th></th>
<th>John</th>
<th>Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>motivation</td>
<td>I(high)</td>
<td>I(high)</td>
</tr>
<tr>
<td>persistence</td>
<td></td>
<td>D(high)</td>
</tr>
<tr>
<td>responsibility</td>
<td></td>
<td>D(high)</td>
</tr>
<tr>
<td>structure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.14: Emotional LS Elements of John and Jeff

the importance of being responsible for his own grades and his own self-satisfaction. John’s LSI profile revealed a score of 54, which is in the mid-range, and therefore not a major element of his learning style. While Jeff’s score on the same scale was a 64, indicating that a sense of responsibility and conforming to expectations in learning situations is a major component of his learning style according to the Dunn model. The forth and final element considered in the Dunn model under the emotional stimuli was that of structure. The responses of Jeff and John to questions of structure indicated that it was not a major influence upon their learning. Their LSI profiles indicated the same. John’s score for this sub-scale was 54, and Jeff’s score was also a 54. John and Jeff’s emotional elements are shown in Table 5.14.

5.4.3 Social Characteristics of John and Jeff

John and Jeff prefer to learn alone and study alone. Both expressed this in several places in the interviews. They don’t even study together, even though all there nursing and college courses are taken together. They do compare their notes and occasionally
ask each other questions, however; this is not done on a planned or regular basis.

Some of their responses were as follows.

With studying, probably alone. Other students try to get me and Jeff to study in a big group, and I’m not for that. I think I’d get distracted. I’m either by myself or with one other person, and if there’s anyone else, it’d be Jeff. I can work with one other person. But as far as like, a big group, in studying, I don’t like to use big groups. But like (for learning) a procedure or something, I don’t care if there’s a big group (like in a hospital setting). (24Jo.1.5)

John said he and Jeff are lab partners in their nursing classes because, “both of us together, we get a lot accomplished... We got the same work ethic.” And although they don’t study together, they would go to each other for help if they encountered problems in their studies.

But like if we’re both having trouble or something, or even if I am or he is, we can always ask each other. We usually start off independently, study-wise, a lot of times. We just go to our own rooms, rather than study with each other at all. If we have a problem, we can, we can talk to each other. (54Jo.2.6)

“As for studying, I’d say 75-25. By myself, and 25(per cent) with someone else.” He also explained that he would want the person he’s working with to at least be on his level, or ahead of him. He mentioned that he would consider and has worked with students ahead of him in nursing school. (24Jo.1.5)

Reflecting back to a high school chemistry class, John commented:

I can remember in chemistry class at the end of my senior year (in high school), like there were four of us, me and Jeff and two other people in a group. And it worked out alright, but I don’t know, it just seemed like when you have a big group like that, and I’ve got a project, the more people I have, the harder it is. You have to get every person to participate and make sure everyone is, and make sure that they do that. If it’s just me and one other person, you get done faster, probably even better than five or six people. Well, maybe not better, because you don’t have many ideas
and stuff, but faster at least. It’s hard to get five or six people thinking on the same wavelength. (25Jo.1.6)

John shared his ideas on being separated from Jeff in elementary school while discussing his social learning preferences. This was one of the most revealing outcomes from the interviews and deserves mention here. John explained,

In elementary school they kept us pretty separate. I’d be lucky to see him once a day. But in high school, I was more independent. In elementary school I was raised with him my whole entire life, from birth until kindergarten, and then the first day of kindergarten, I didn’t see him all day and I said, ‘Gee.’ You know? In high school, it really didn’t matter to me that much, as much. I probably saw him more than I probably wanted to (he laughed as he said this last sentence). (48Jo.2.4)

Now, in nursing school, John and Jeff spend most of their academic day together. However on the weekends, they are often apart, each at their respective girlfriend’s home and family.

Jeff’s comments reflected many of the ideas that John’s did. On group learning, he said, “I really learn by myself. Like in groups, sometimes they can get distracted, start talking about social events or whatever, and get away from the studying part.” (39Je.2.2) He continued to explain,

I never got caught up in it that much. There’s a lot of people here (in nursing school) who get together and study before a test and stuff. I just don’t feel I can cover enough material fast enough and straight enough with a group thing. I like to come, be alone and study it on my own. Some people do a lot of talking and don’t get much studying done. (17Je.1.4)

Jeff explained that he did at one time study with John.

We started to in middle school, and high school we did, but ever since we started college, we don’t study together. I mean like we go over our notes, and make sure we got the same notes, make sure we didn’t miss nothing in lecture, ask each other questions every once in a while. But actually none of the core concepts. I sit down and do it myself. (16Je.1.4)
Both John and Jeff commented that in clinical learning experiences they preferred working with another more experienced person or with the instructor and didn’t mind even being watched by their peers. So their responses to group learning in clinical situations differed from other more traditional study situations.

The Dunn LSI profile for the social element of learning style indicated that both John and Jeff were in the mid-range, and that even working alone was not a major part of their learning style. This was one element where their responses to interview items appeared to emphasize their desire to work alone. John’s score on this element was 45, while Jeff’s was 43. On the preference for authority, their scores were more indicative of a preference for the presence of authority figures in learning situations. This was reflected in their willingness to be among the first to demonstrate newly learned techniques or procedures in front of their peers / patients as long as the instructor was nearby. They even spoke of times when they were in high school and the coach would often have them demonstrate new wrestling holds or strategies, as well. Both scores for the authority element, John’s score of 60 and Jeff’s score of 63, could be taken as preferences for authority figures or experienced persons when learning new or difficult information or procedures. Table 5.15 summarizes John and Jeff’s social elements.

5.4.4 Perceptual Modality Preferences of John

John’s responses in the interviews reflected preferences for visual and kinesthetic experiences. He also had many references to visual and tactual experiences. His comments as to how he prefers to be presented new or difficult information follow.
<table>
<thead>
<tr>
<th></th>
<th>John</th>
<th>Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>self</td>
<td>I+(alone)</td>
<td>I+(alone)</td>
</tr>
<tr>
<td>group</td>
<td>I(dislike)</td>
<td>I(dislike)</td>
</tr>
<tr>
<td>authority figures</td>
<td>I+(nursing)</td>
<td>D(wants)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.15: Social LS Elements of John and Jeff

“By showing me. Watching them do it visually is better than just hearing it. I like to see it done.” He went on to explain that in many instances if it were a procedure, he’d also prefer to have the one explaining “follow through with me doing it,” at least at first. (29Jo.2.1)

In another place John emphasized the preference for visual and tactual experiences since nursing involves a lot of clinical learning. He explained that it helps if instructors “show me” and give him a chance to “try it.” He confirmed that many of his nursing course instructors teach that way. He continued with, “that’s probably one reason I’m doing nursing.” (62Jo.3.1)

When asked how he’d normally learn a new play in football, John said, “diagram of the play, and to walk through it with the whole team. Everyone walks through it. Then, they have the coach explain, do this and this, for each individual, you’ll do this, block this way, or what ever.” (88Jo.3.5)

John’s preference for hands-on involvement was echoed in several comments such as evidenced in the following. “I like doing them (clinical procedures), showing that,
I can participate. I like showing that I know my stuff and I know what I’m doing with a procedure.” He commented that he actually prefers the clinical learning experiences to the lectures. “Yeah, any minute, I like hands-on stuff.” He said he was good with manipulation of objects with his fingers and that he has “steady hands and stuff, yeah, I’ve been told that anyway,” by people in the phlebotomy class, in which he was taught the procedures to draw blood. (34Jo.2.2)

In textbooks, John finds it helpful to use and refer to descriptions and diagrams. “Well, I like both, a description and followed by a diagram.” He generally said he would refer to the diagrams first and then refer to the descriptions for further clarification. (42Jo.2.3)

John also explained his extensive use of highlighting in his studying. “I highlight everything. I highlight a lot.” And he goes back to what he’s highlighted in the text. He uses his notes again and again in preparation for tests too. “I usually read all my notes, at least once a night, just keep, I do more than read them, I study them and look at my notes pretty much.” (32Jo.2.1)

When asked how he’d like to receive the notes from a peer if he happened to miss a lecture, John responded, “I’d take their notes and copy them word for word. Then a summary, telling me what happened. I think that’d help.” (52Jo.2.5)

When given a situation, such as having to find one’s way to a destination in an unfamiliar part of town, John said he’d prefer to have the directions “on paper, but just like, simple. Like, not a lot of detail. On paper, as plain as can be just so it will get me there.” He added, “no maps, just hand written paragraph form.” (30Jo.2.1)

John’s responses to the embedded revealed that he preferred auditory and visual presentations of information slightly more than tactual presentations. His Dunn LSI
profile revealed that he was a strong auditory learner with a score of 64. His lowest preference for visual which was 38 on his profile.

5.4.5 Perceptual Modality Preferences of Jeff

Jeff’s responses to interview items assessing his perceptual modality preferences revealed a preference for visual and tactual learning experiences. Many of his comments returned to such meaningful exposures to new or difficult information through these modalities.

Jeff relies on pictures and diagrams in many of his college classes, especially in his nursing courses.

Yeah, in anatomy, I follow the book, when I’m writing. Because she (the instructor) goes from the book too. Like when she starts talking, I’ll write it down, but then I’ll go look at the diagram, and make sure I get the right part down. So when I get home, I fill in the detail, a lot more. (45Je.2.4)

He continued to explain that,

Yeah, I’d rather have diagrams, but most of the time, at least here, they don’t use diagrams as much. Like when I’m writing, like when I’m taking a written test, I picture in my mind that diagram and what part, and kind of take it from the diagram and put it into my writing. (45Je.2.4)

Jeff also explained the importance of seeing new information presented and then having the opportunity to apply or try out something, especially in his clinical experiences. “Seeing it, that way you know for a fact the way it’s done. I mean you can imagine what it should be, but I don’t think you really know for sure until you see it.” He continued to explain his view on lab work and clinical experiences, “I like it. It lets you apply what you’ve learned in lecture. You can really see what all the lecturing means when you get out and do it.” He also explained that he’s very good
at performing many tactual procedures in his clinical classes and hardly ever misses arteries or veins when performing injections or blood draws. (33Je.2.2)

Jeff explained that one of the techniques he often uses in learning anatomy material is that of writing information on diagrams and illustrations in his textbooks. I’ll see a diagram, draw an arrow to it and then write what the muscle is, what it’s made of, and the tissue, same sort of thing for bones and what part of the body it’s in. Draw arrows to the diagrams.

He studies for tests using the diagrams in his review of the material. “I go over it and over it, look at the diagrams, try to apply it, find different pictures of the bones of the body. (58Je.3.1)

He also highlights often when studying.

Yeah, I highlight all the time. I rarely highlight the whole page, mainly just when I’m reading something, like when I’m studying. If I highlight it, it slows me down, and let’s me think about it, I guess, when I highlight it, I guess highlighting is more interesting to look at than pencil and paper. (31Je.2.1)

Jeff also returns to review what he’s highlighted in preparation for tests.

He, like John, explained how he learns new plays in his weekend football league.

The way my coach has been doing it, and I like it, we have a play book and he draws the up, and look at it and get the patterns right, and study that. And then go out in the field and run through it. And learn it that way. (41Je.2.4)

He responded that it was a preferable way for learning new sports plays and techniques, even when he wrestled in high school.

In responding to questions about lecture situations, Jeff said he prefers to hear, write, and perform manipulations with that information, if and whenever possible. “Probably a lecture to start, and then go out and actually do it. Actually do it
myself and then have a supervisor standing by to see that I actually do it right.” His comment on having a person in authority or one of experience, such as an instructor, watch him when he’s mastering new procedures was echoed by his brother John as well.

Jeff continued to explain, “If someone gives me a lecture on something, for example cells, it’s more understandable to see what they’re talking about. And when I see a picture of it, I’ll record it from there.” (30Je.2.1)

Jeff distinguished the difference between learning something in a lecture situation, in which he would rely more on diagrams; as opposed to learning a procedure, where he’d prefer to be involved in kinesthetic experiences. (44Je.2.1)

In lecture I write down the basics and then I have a lot of holes to fill in. We got diagrams in the book. I looked at the diagrams, by each of the diagrams I drew an arrow and wrote what she said in my notes about it, beside it. So I looked at the diagram and followed the arrow and told what it is, what it does, etc. Kind of like looking at it and then writing beside the diagram. (37Je.2.2)

This was the same technique that John described in his study strategies in many of his nursing courses.

Jeff takes notes often in his college lectures.

I like to get an outline of what they’re saying. I don’t like to write word for word. I think if you listen, you can learn a lot just as much as you can write it down. I like to get the main ideas and then go in the book and fill in, if they follow the book. Now some teachers don’t follow the book at all, then you’ve got to write it. I feel I have to write everything down, to get everything that’s said. (74Je.3.3)

In this section he explains how he does rely on auditory information and the textbook. His comments on his reliance and use of the text closely match those of John’s.
In preparation for tests, Jeff will consult both his notes and his textbook with his notes written on diagrams and illustrations. He also commented, “Yeah, oh I wear my papers (notes) out going over them.” (46Je.2.4)

Jeff’s response to learning or remembering directions to a new section of town was to rely on a map rather than have directions written in paragraph form. This differed from John’s preference for written directions.

Jeff described one learning experience he had this past summer in learning how to drive a truck for his dad’s gravel hauling company.

This summer I followed one of my dad’s drivers, I rode with him a couple of days, one of his usual drivers, and then the next couple of days I drove and he just watched me. I got to watch and see how he shifted gears, and how to load the truck and all that. I watched him a couple days, and then he watched me. The truck I drove had a seven speed in it, it was a General ’85, but it was all restored. It’s the hardest truck my dad’s got, to shift. But I did real good at it, actually. He’s got other trucks that are easier to shift. (49Je.2.3)

It was interesting how he emphasized that he’d mastered the shifting routine on the most difficult truck, and that he preferred to watch and then try it for himself.

He also spends time working on the trucks, servicing them, for his father on the weekends. He commented on how he likes working on them and will often lose all track of time in doing so. He also said he’s good at fixing and figuring out most things mechanical. “Yeah, I like to. Kind of like if anything that’s broken, I’ll fix it, even if I’ve never seen it before. I’ll try to figure it out, yeah.” Jeff continued to explain that he was that way even as a youngster, “Yeah, I was always taking apart, just anything, my bike, and putting it back together.” (69Je.3.2)

The embedded survey revealed a slight preference for auditory and visual learning experiences over tactual and kinesthetic experiences. Jeff’s actual responses matched
<table>
<thead>
<tr>
<th></th>
<th>John</th>
<th></th>
<th>Jeff</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>auditory</td>
<td>D</td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>visual</td>
<td>I</td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>tactual</td>
<td>I</td>
<td></td>
<td>I</td>
<td>D</td>
</tr>
<tr>
<td>kinesthetic</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.16: Perceptual Modality LS Elements of John and Jeff

Those of his brother closely. Jeff’s Dunn LSI profile indicated his perceptual strengths were both auditory and tactual, with respective scores of 76 and 63. The member check reconciled this discrepancy by saying that in many learning situations Jeff relies on a combination of perceptual modalities and that combination would most often involve auditory and either visual or tactual experience. The grounded survey responses indicated this pairing of other perceptual modalities with an auditory preference as well. Table 5.16 summarizes their perceptual modalities.

5.4.6 Physiological Characteristics of John and Jeff

John responded that he often has something to drink when he’s studying and that it helps him concentrate. Jeff was less sure of the role of something to drink or snack on while studying. Both John’s and Jeff’s LSI profiles indicated that intake was an important element of their respective learning styles. John’s score on intake was 61, while Jeff’s was 64.
On the physiological element of time of day, John reported that his best time to study or learn information was evenings after five pm and his worst time was between ten in the morning and two in the afternoon. Jeff’s preferred time according to responses in the interviews was evenings, around six, seven, or eight pm. Both expressed their preference for evenings, however; their Dunn LSI profiles revealed that they had a time of day stronger preference for afternoons and a preference for evenings. Their preferences for afternoon were 75 and 67, for John and Jeff respectively. While their LSI scores for evenings were 39 for John and 40 for Jeff. The preference for afternoons was further from the mid-range, and thus stronger than their preference for evenings on their LSI profiles.

With regard to the element of mobility, neither John nor Jeff expressed a strong need for mobility when studying. John expressed that he does often move during studying and he does have a squeeze ball that he uses occasionally during study times. However, he reported that moving around during studying was not a help to his level of concentration. Jeff reported that he didn’t have a need for mobility during study or learning periods. Their LSI profiles indicated that mobility was not a significant element in either of their learning styles. John’s score on this element was 59, while Jeff’s was 49.

5.4.7 Global Versus Analytic Characteristics of John and Jeff

The global and analytic characteristics of John and Jeff were similar according to how they responded to various situations and questions in the interviews. Their responses to the grounded surveys dealing with characteristics of global and analytic learners were also alike in some ways.
<table>
<thead>
<tr>
<th></th>
<th>John</th>
<th>Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>intake</td>
<td>I(prefers)</td>
<td>D(prefers)</td>
</tr>
<tr>
<td>time of day</td>
<td>I(afternoon evening)</td>
<td>D(afternoon evening)</td>
</tr>
<tr>
<td>mobility</td>
<td>I(evenings)</td>
<td>D(afternoon evening)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.17: Physiological LS Elements (other than Perceptual Modalities) of John and Jeff

Regarding concepts and details when presented with new or difficult information, John responded with many interesting comments.

I like to see the whole picture and then the concepts. Kind of like anatomy, you learn the fine details, but once you learn the fine details, after awhile, a couple of chapters, it will fall together, and that’s the part I like: watching it all come together. (72Jo.3.3)

He also spoke of the importance of matching the expected results form doing a lab experiment, a characteristic mannerism of being analytical. “Yeah, I like when you come out with the right one (correct results). I don’t like to come out with the wrong one. It seems like I wasted my time.” (19Jo.1.4)

John continued to explain: “I don’t like to leave a lot of room for interpretation. I like it to be like, like her test is all these definitions she’s done and everything from her lecture... I don’t like to leave room for interpretation.” He went on to say he’d rather have specifics than open-ended directions. (39Jo.2.3)
On the need for closure, John explained: "I like closure. I love it when the teacher is writing stuff and in the lecture they say they covered this, this, and this, and summarizes it for you." (77Jo.3.3)

In his comments and on the grounded surveys assessing global and analytic characteristics, John’s preferences indicated that he is flexible, relying on both analytic and global processing strategies in learning situations. His LSI profile revealed that he preferred two of the five global elements, and none of the analytic elements. Therefore, John would be considered neither a strong global or strong analytic processor in his learning style.

Jeff’s comments in the interviews and on the grounded surveys included an even mix of global and analytic responses. Some of his explanations showed a reliance on global and analytic processing strategies. When asked if he preferred to have details or major concepts, Jeff responded, “Major concepts. Usually the major concepts. Like in anatomy, first before we learn about the bones, first we learn about, first we learn the major concepts.” (64Je.3.2)

He also emphasized his desire to complete tasks once he has started them. “Yeah, I’m usually consistent about that. I finish what I start.... Yeah, start, get done, and move on to the next one.” (50Je.2.5)

In another place he recalled that he had had an instructor who began her lectures with a related story, and how he liked beginning the class that way. That would be one event or strategy that would appeal to global students.

Jeff’s remarks and his LSI profile indicated a balance in preferences for global and analytic processing strategies. His LSI profile indicated a preference for intake when studying, a global characteristic; and a preference for being persistent, an analytic
<table>
<thead>
<tr>
<th></th>
<th>John</th>
<th>Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>global</td>
<td>I(balanced)</td>
<td></td>
</tr>
<tr>
<td>analytic</td>
<td>I(balanced)</td>
<td>I(slightly)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.18: Psychological LS Elements of John and Jeff

class characteristic. Those were the only global or analytic preferences expressed according to his Dunn profile.

5.5 Mike and Dan

Mike and Dan were interviewed upon completion of medical school at a well-known major university in the Midwest region. They had pursued the same undergraduate major, zoology, but different minors. Mike minored in business, and Dan minored in psychology. Both decided upon medical school partly due to their father having been involved in a serious auto accident and having to cope with his medical condition.

5.5.1 Environmental Characteristics of Mike and Dan

On the environmental element of sound, both Mike and Dan indicated on several occasions during the interviews that they preferred to have a quiet learning environment when studying. Although, quiet instrumental music was mentioned as being unobtrusive to their studying or concentration. The presence or absence of sound, however, was not continually mentioned as a major consideration of their learning environment. Their LSI profiles indicated the same. Mike’s profile on the element
sound was 47 and Dan’s was 52. Both of their scores were indicative of flexibility on this element.

On the element of light, Mike expressed a preference for bright light to dim light while studying. Dan expressed a preference for dim light in the room in which he is studying, but bright light on or over his desk area. Dan commented, “It actually helps me concentrate better with a dark room and a bright light on my desk.” (5D.1.1)

The Dunn LSI profile score of both Mike and Dan indicated that lighting was not a significant element of their respective learning styles. However, in considering where their score were along that continuum, there was more of a contrast. Mike’s score of 58 was towards the preference for bright light, and Dan’s score of 40 was on the line indicating a closer preference for dim light.

On the element of temperature, Mike and Dan expressed indifference as long as the temperature of the room in which they were learning was not extreme. Both expressed dislike of extremes in temperatures in the interviews, but it was not considered or mentioned repeatedly throughout the interviews. Therefore, temperature was not considered an essential element of either of their learning styles.

Their Dunn LSI profiles indicated that temperature was not a significant element for either Dan or Mike. Mike’s score on this element was 50, while Dan’s was 56. Both falling in that midrange area that indicates more flexibility than a strong preference.

The final environmental element, room design, was discussed as being more important for both Mike and Dan. They both expressed a desire to do most of their studying at a formal desk and in a comfortable chair with good back support. Both Mike and Dan mentioned that they have “bad backs,” and actually find a formal arrangement when studying more conducive to long periods of concentration.
<table>
<thead>
<tr>
<th></th>
<th>Mike</th>
<th>Dan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light:</td>
<td></td>
<td>D(dim)</td>
</tr>
<tr>
<td>Temperature:</td>
<td>I (moderate)</td>
<td>I (moderate)</td>
</tr>
<tr>
<td>Design:</td>
<td>I+ (formal-bad back)</td>
<td>I (formal-bad back)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.19: Environmental LS Elements of Mike and Dan

Their LSI profiles indicated the same scores, 59 for each, which is toward the formal design preference.

5.5.2 Emotional Characteristics of Mike and Dan

Both Mike and Dan had responded to interview questions regarding motivation, especially as it related to their decision and success in medical school. They are very motivated individuals who both exhibit a great sense of personal motivation to learn and understand the world around them. They are very self-motivated in learning science too.

Mike’s response details some of the motivational influences in his decision to study medicine and science.

I’ve always known that I was going to be a science person... I was the president of my sixth grade science club, and that sort of thing. And my brother was always, always wanted to be a doctor, and I always said I wasn’t going to be. But then my father got in a car accident, and was in a lot of different hospitals and dealt with a lot of different doctors, and I think it came to the point that I was so involved with it with my father, I realized it was something that I could do. And being naturally gifted in
the sciences, it kind of was a perfect fit. And when I worked in a lab at a medical college, a pathology lab, after high school, and that also cemented my career plan. (3M.1.1)

Mike continued later to explain his source of motivation to learn new or difficult information.

I think it’s all me. I don’t think it’s anything external pushing me. I would say growing up with my brother, I think competition between us is a big part. There’s nothing else. Except maybe my foundational, my parents didn’t push me, I think I have this innate drive to want to be the best I can.” He went on to explain the type of competition shared with Jeff was one of competing in a friendly manner. (14M.1.3)

Mike is motivated by knowing more, or as he had put it, “knowledge for knowledge sake.” He continued later to explain, “Yes, grades were extremely important to me. It was also just knowledge, sometimes I like to watch Jeopardy, just the facts. I like just knowing things.” (16M.1.4)

Both Mike and Dan explained the important role that family vacations, educational vacations had on there curiosity about the world. They also developed a fondness for traveling and of map reading from such trips. Their parents were instrumental in encouraging them to learn.

At one point their parents thought Mike was putting too much pressure on himself to achieve in school so as Dan explains, “my mom even offered to pay Mike to get a ‘B,’ because she thought we would put too much pressure on ourselves, if we had to get an ‘A.’ I never took her up on it, for them it wasn’t necessarily a matter of getting an ‘A,’ it was a matter of doing your best.” (9D.1.2)

Again, Dan explained that his main motivation in learning was for himself. “One, just myself, I like to learn, even if there’s no test, I still push myself to do that. Also, I like to succeed, get good grades and so forth.” (31D.2.1)
The Dunn LSI profile for Mike indicated that motivation was very important as part of his learning style with a score of 60. Although 60 is right on the upward boundary, it would appear to be an important part of his learning style. Dan’s LSI profile revealed a score of 57 on the element of motivation. Both of these young men were very motivated individuals and competitive in their academic pursuits, so their scores on this element are somewhat surprising. However; to have a mid-range score on such a scale is not to discredit one’s personal motivation, just relate it to the part it plays in helping one learn.

On the emotional element of persistence, both Mike and Dan gave responses attesting to their persistence in learning situations. Mike’s and Dan’s comments follow as examples.

I’m the kind of guy, that’s one of the things that bugs me about myself, I don’t give up easy enough. So, I’ve had thing where I’d work on one problem, and I would keep working until I find the answer. I don’t think I would let go as easily as I should have.” He continued to explain that to figure things out for himself is his preference. “A lot of times that’s what I do. I don’t hesitate to ask my brother, or ask somebody, I’m good at asking professors for help if I need it. A lot of times if I have alternatives, I’m the kind of guy that I would find the answers some way or another. I’ll work to find the answer until I find it. (17M.1.4)

“I think I’m very long term oriented. I could learn things, I like to learn things rather than learn for the test. I like to learn things to know them for the future. (much emphasis on the last phrase)” (27M.1.7)

Dan went into less detail in his answers on how persistent he is on learning tasks. “I’m very persistent, I don’t like starting something that I don’t finish. So I see it through to the end, usually. Even if there are no external rewards, I push myself.” (33D.2.1)
The Dunn LSI profiles of Dan and Mike were in the mid-range values on the element of persistence. Mike’s profile score was 56, while Dan’s was 58. Both scores indicated flexibility on this element as an important part of their learning styles.

On the element of responsibility and conformity, both Dan and Mike gave examples in the interviews where they conformed to learning expectations in formal school settings. They both took their learning tasks seriously.

Mike commented:

I’m the kind of person that would never want to come in late, always be on time, will always do the whole assignment, and that sort of thing... Responsibility, dependability, if you say you’re going to do something, do it. If you say you’re going to be there at 7:30, be there at 7:30. That sort of thing. That’s definitely my childhood. (38M.1.9)

It would appear that their rearing had imparted a large sense of being responsible or conformity upon Mike, but he later explains that he feels most responsible to himself. “Mostly me. I’d say it’s mostly me. If someone tells me to do something, then, I put pressure on myself to do it.” (41M.2.1)

A lot of times in medical school an attending or resident will be talking about a certain subject, and say, ‘Mike, know that by tomorrow.’ That happens quite a bit where we get given responsibility, and so I basically, I like to get information and I’ll get one of the big books and sit down until I understand it. I’m very persistent about that sort of thing. (41M.2.1)

Dan’s comments in the interviews regarding the element of responsibility were similar to his brother’s. He too, spoke of being mostly responsible, “to myself, to be honest. Mostly, myself.” He also spoke of times when he didn’t do his best or receive his expected grade on some assignment, he would be likely to think, “It was my fault. It wasn’t the situation. It was my fault.” (11D.1.2)

Dan’s takes tasks given to him by others very seriously. “I think it’s important that I take it seriously and I do what they want me to do and what I’ve told them
I would do. I think because if the situation were reversed, I would want the same.” (34D.2.1)

The times when medical school demanded that medical students show responsibility was also highlighted in Dan’s responses. “I think if you want to talk about my current situation with medical school, we’re given a lot of responsibilities to see that patients have certain tests done and lab work up, stuff like that. That’s responsibility issue there.” He again said that he feels most responsible to himself. (34D.2.1)

The Dunn LSI profiles for both Dan and Mike indicated that responsibility and conformity was not a major element of their learning styles. Mike’s numeric score for this element was 52, while Dan’s was 54.

On the element of structure, both Dan and Mike expressed an appreciation for structure in learning material and they described different methods that each used to establish such structure. Mike’s comments in the interviews indicated that he prefers to keep a regular schedule whenever possible. And when Mike studies, he has a plan and budgets time for assignments and studying.

Mike explained:

I’m very good at budgeting time for myself, if I have, I’ll have an agenda. I would say an hour for this subject. And I have to get through it, and pace myself accordingly. So, I’m not one to just study and then, when I go to bed realize I’m far behind. I often times will write down a schedule and stick to it. (61M.3.1)

He went on to explain that he also makes and uses lists to help plan his study time.

Dan also explained how he would plan his study time.

In general, in college and early medical school, I would work ahead. And get done ahead of time. And I like to study and spread things out. For example, if I had a test on Thursday, I would start studying on Sunday and study a little at a time, and the repetition, I thought, was good for me,
<table>
<thead>
<tr>
<th></th>
<th>Mike</th>
<th>Dan</th>
</tr>
</thead>
<tbody>
<tr>
<td>motivation</td>
<td>I(knowledge)</td>
<td>D(high)</td>
</tr>
<tr>
<td>persistence</td>
<td></td>
<td>I(knowledge)</td>
</tr>
<tr>
<td>responsibility</td>
<td>I+(prefers)</td>
<td>D(wants)</td>
</tr>
<tr>
<td>structure</td>
<td>I+(prefers)</td>
<td>D(wants)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.20: Emotional LS Elements of Mike and Dan

and really helped me learn. Rather than studying really hard one night four hours, I'd spend an hour a night, with repeating it, with repetition. (14D.1.3)

On the Dunn LSI profiles, Mike's score of 64 indicated his strong preference for structure. Dan’s score was 69, and was right on the line, indicating a strong leaning towards preferring structure as part of his learning style, too. Table 5.20 compares the emotional LS elements of Mike and Dan.

5.5.3 Social Characteristics of Mike and Dan

The responses of Mike and Dan regarding the social aspects of learning strongly indicated a preference for learning alone. They mentioned times when they each resented or felt hindered in their learning experiences by being forced to work in groups. Mike elaborated on his former and recent group learning experiences.

Except I don’t enjoy large groups. For instance in medical school, in the first two years, there are groups of about twenty, which is too large. I don’t enjoy that now. I enjoyed that in elementary school, in high school, but I don’t enjoy that now. (22M.1.5)
Mike continued on to explain:

In medical school when we had to separate into groups, for afternoon sections of 20 or more, my learning went way down. I don’t know why, in that situation, I just don’t participate in large groups. Maybe I’m just not a public enough person, that makes me nervous in front of other people, and when I do that I just can’t concentrate? If you wanted me to do poorly in school, you’d put me in a group of twenty-five people and make it really interactive. (22M.1.5)

Mike explained that it wasn’t so much of a problem in elementary school, but as he progressed in high school and college it became a larger factor for him.

In elementary school, I don’t think I noticed the problem or what to do about, cause I was very, outgoing, but I was always very good with the groups. And I think as I got older, I enjoyed it less and less, and got less and less out of group work. I don’t know why. (36M.1.8)

He noted that small groups are more common and practical in most of his dealings with people in his experiences. It’s also important to note that Mike and Dan attended small public schools in a rural community in northwestern Ohio.

Dan expressed some of the same ideas toward group and working alone.

I never liked group work, ever. I couldn’t go at my own pace. Whether that still would have affected me, it didn’t matter. I liked the flexibility of being able to go at my speed and be in control of what I learn. And I often times got frustrated for having to waste time or spending time with something that someone else didn’t know that I did. I found it was so much of a time-practical point of view, with myself, was much better. (17D.1.4)

Dan explained that when necessary he would seek out advice or the help of another intern or person. And he mentioned that there are times when working as part of a team can have advantages. But generally, he stated, “I’m not comfortable where there’s many people who I’m somewhat placed with the same problem.” He
emphasized repeatedly that he'd really prefer to working by himself in most learning situations. (17/18D.1.4)

Mike and Dan also pointed out that they never really studied together in high school, college, or medical school. Occasionally they would have questions and might ask each other those, but for the most part they would study alone.

Mike's LSI profile indicated that he was more flexible, having a score of 45, in the mid-range on the social element. Dan's LSI profile score was 40, on the line and very close to indicating a clear preference for learning alone. These profile scores did not appear to reflect the strong statements each young man had made about preferring to learn by themselves.

On whether Mike and Dan prefer to have authority figures present when learning new or difficult material, responses were similar. They both spoke of learning situations, especially in medical school, when they would work closely with experienced researchers and physicians, and neither gave indications of having a strong preference for or against their presence. However, their profile scores for the presence of authority figures in learning situations differed. Dan's score, a 66, indicated a strong preference for their availability, while Mike's score, a 44, was in the midrange, and indicated that this was not an important part of his learning style. Table 5.21 summarizes the social elements of Mike and Dan.

5.5.4 Perceptual Modality Preferences of Mike

The perceptual modalities that Mike discussed as most important in his learning situations were visual and tactual. He emphasized the importance of seeing diagrams
<table>
<thead>
<tr>
<th></th>
<th>Mike</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>self</td>
<td>I+(alone)</td>
<td>I(alone)</td>
</tr>
<tr>
<td>group</td>
<td>I(dislike)</td>
<td>I(dislike)</td>
</tr>
<tr>
<td>authority figures</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data  
I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.21: Social LS Elements of Mike and Dan

and "drawing things out." (62M.3.1) Mike also spoke of the importance of highlighting for him and how he would often return and repeatedly study his highlighted notes or readings.

Mike also commented on the value of repetition for his studying.

I like to go over things multiple times. I'm not the kind of person that, some people I know study, they go through everything really, really thoroughly once, or twice. I like repetition. I just go over it, over it, and over it. (74M.3.4)

Mike's responses to the embedded survey indicated that he preferred visual and tactual tasks. His Dunn LSI profile indicated the same with score of 63 for visual and 60 for tactual modalities. His lowest perceptual modality score was the auditory modality, with a score of 41.

5.5.5 Perceptual Modality Preferences of Dan

Dan discussed his perceptual modality preferences quite extensively throughout the interviews. He emphasized repeatedly those of visual and tactual. When asked
which modality he preferred he responded in various ways, yet often returning to the preferences of tactual and visual.

When asked about trying to remember something he was trying to learn, Dan said he tries to, “clearly picture it in my head. Clearly.” He continued on to explain that when given a choice of various different leisure activities he would probably prefer to work at something with his hands. “Which would I prefer most? I prefer doing something with my hands.” But he did state that that was a difficult choice. (19/20D.1.5)

Dan mentioned that he often finds himself manipulating a pen or some object in his hand when he’s studying. And this discussion led into his telling of the most remarkable use of perceptual modality in his learning process.

And what I do, like I said, repetition is huge and very important for me. A lot of times, I forgot to mention this earlier, I’d have a piece of paper, blank piece of paper, and a pen in my hand or pencil, and I write stuff down as I study. Not necessarily notes, nothing that I’m going to read again, ever. But just in a way that I can process information, if that makes sense? I’ve found that, for example, if I had a list of different enzymes, and a certain cycle in the body, I would write down on the piece of paper as I studied, the enzymes, but not that I could read it again. If that makes any sense. I just sort of jot down. That helps me process, rather than just simply read it and not think about it, if I can turn it into writing. Does that make any sense?... I don’t think it’s just moving the fingers, it had to be with a pencil writing stuff down, it couldn’t just be with a pencil writing on air. Well, that couldn’t hurt, but it’s best with a piece of paper there. Usually I’d write, maybe, sometimes just the first letter of the word. It wouldn’t have to be the whole word. (25/26D.1.6)

Dan explained that he carries a little notebook with him on his rounds at the hospital and often uses the pages in that book to help him memorize or learn as he tries to commit new or difficult information to memory. He just throws out the pages and said the writing appears as scribbles, not as notes or phrases.
Dan continued:

I’m a very, very visual-spatial kind of person, in my learning. So, yeah, that helps a lot. In fact I carry around a little notebook in my pocket, and I jot stuff down in medical school, and it helps me remember and think, not that I’ll ever read this again... Rarely do I refer back to it. I don’t use a calendar or anything to remember, so almost never do I refer back to this. It’s a way I can process learning. (25D.1.6)

Dan explained that this is a technique that he didn’t use in high school or undergraduate college. He said,

For me a lot it has to do with complexity and volume. Not just something to learn, but if it’s something easy to learn, there’s no need for it. If it’s hard or more so, something with large volumes, I would use this. (26D.1.6)

Dan discovered and began using this technique on his own, sort of a self-discovery. No one taught it to him.

In another place Dan said that he’s not a fan of graphs and tables, but instead prefers text or short paragraphs to explain ideas. In his textbook readings he did comment that he tries to give more attention to the text than to accompanying diagrams and charts. (28D.1.6) In lecture situations, Dan expressed his preference for demonstrations or diagrams over verbal methods of presenting information. In most situations, but not all, Dan said that would be his preference. (51D.3.1)

Dan described the use of his notebook as a short term memory tool, that helps him remember details, not the main concepts. The main concepts, he said, come easier than the details. (44D.2.3)

Dan uses highlighting.

...and I would also highlight in different colors, different colors for organizational purposes. For example, main topics would be, let’s say green, yellow would be smaller topics, and so forth. That way when I look back on the page, the colors would help me look at the whole picture, with the organization in mind. (66D.3.4)
<table>
<thead>
<tr>
<th></th>
<th>Mike</th>
<th>Dan</th>
</tr>
</thead>
<tbody>
<tr>
<td>auditory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>visual</td>
<td>I</td>
<td>D</td>
</tr>
<tr>
<td>tactual</td>
<td>D</td>
<td>i+(writing)</td>
</tr>
<tr>
<td>kinesthetic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.22: Perceptual Modality LS Elements of Mike and Dan

The Dunn LSI profile for Dan indicated that his strongest perceptual strength was visual, a score of 67, followed by tactual, with a score of 63. His lowest perceptual modality preference was auditory, with a score of 38. Their perceptual modality strengths are shown in Table 5.22

5.5.6 Physiological Characteristics of Mike and Dan

In discussing intake when studying, Mike stated that it’s very important that he have a glass of water. Mike takes breaks to eat but having water when studying was repeated. Dan stated that having something to drink or eat is more of a way to make him comfortable and remain awake if he’s feeling tired.

Their LSI profiles indicated the opposite of what their interview responses indicated. Mike’s score for intake was 56, and did not reveal intake as an important element of his learning style. Dan’s score on this scale was 64, showing intake to be an important element in his learning style.
On the physiological element of time of day, each responded differently to the interview questions. Mike did not express a strong preference for one time of day over another, although he did say that late morning or late afternoon would probably be the most optimal time for him to learn. Dan expressed a consistent preference for evenings around nine or ten o’clock and late night, or right around dinner time, about five o’clock. He said mornings would probably be the worst time for him to study.

Dan explained, “In the mornings I like to be more of a doer, an active doer, up walking around the hospital doing things with my hands, to stay awake, or just to stay motivated.” (23D.1.5)

Mike’s LSI profile did not indicate that time of day was an important element of his learning style. Dan’s LSI profile indicated that evening was his optimal time of day.

The need for mobility was not strongly expressed in either Mike’s or Dan’s responses to interview items. However, each was aware of times when movement was recognized as a help in keeping them alert during long study periods. Mike said that he was aware that he moves around in his seat a lot, but that this was again more to keep awake and comfortable than as a help to his level of concentration.

Both Dan’s score, 53, and Mike’s, 55, on the their LSI profiles indicate that mobility is not an important element for either of their learning styles. Table 5.23 summarizes the physiological LS elements of Mike and Dan.
<table>
<thead>
<tr>
<th>intaking</th>
<th>Mike</th>
<th>Dan</th>
</tr>
</thead>
<tbody>
<tr>
<td>I+(prefers)</td>
<td>I+(not after meals)</td>
<td>I+ (not after meals)</td>
</tr>
<tr>
<td>D(prefer)</td>
<td>D(evening)</td>
<td>D(evening)</td>
</tr>
</tbody>
</table>

I+ = Strong Preference According to Interview Data
I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.23: Physiological LS Elements (other than Perceptual Modalities) of Mike and Dan

5.5.7 Global Versus Analytic Characteristics of Mike and Dan

Many of Mike’s and Dan’s responses to interview questions included global and analytic responses. They often qualified some of their answers and descriptions with, “it depends.” Neither Mike nor Dan showed strong preferences for either global or analytic processing styles. Likewise, on the global-analytic grounded survey, both Mike and Dan did not demonstrate clear preferences.

Some of Mike’s responses included statements that were analytic, but these were often tempered by some global responses. The following description of a professor whom Mike found very effective gives some evidence that Mike uses analytic strategies.

She did a lot, she’ll have handouts that she passed out. She did a lot of board work, she did a lot of drawing at the board. She was very good at drawing a structure, while she was talking about it and explaining it to us. Which I think was helpful too.

He went on to explain how she kept to the schedule and syllabus. She, “never, ever, ever varied from it.” When asked if that mattered to Mike, he said,
It does. Yes, it does... It's the organization overall, and it gives people a sense of security, a sense of 'I know I have a lot to do today, and I won't quit until it's done. And once it's done, I know, that's what's expected of me.' The sloppy teachers, who give you no guidance, are ineffective. (71M.3.3)

Another place where Mike's preference for analytic processing surfaced in his preference for closure to assignments and information. His response to the question, 'Is it ok to leave some things undone at the end of a lecture or a unit that you have worked on it studying?' follows.

"I hate that. But it happens. At least when I'm talking to patients, when I'm planning my own, I try to get an overall picture at the end, and try to make everything fit into a nice, neat package." (47M.2.2)

Mike went on to explain that one of the reasons he had decided to go on to study internal medicine was the opportunity to have continuity and follow-up with patients. "It's nice to do internal medicine because, we see patients over years, and we know what happens to them. And I like that. I like developing a relationship with patients." (50M.2.3)

In other responses Mike expressed some qualities of global and analytic processors. For example in the quote that follows, Mike expresses his valuing of details and major concepts.

Both. I think I like both. I like the overall picture. I love putting things in their place in the overall scheme of things. But I like working with the details too... But the things I understood and learned...I'm more of a detail person. (48M.2.3)

Mike prefers completing tasks, learning tasks, in a "Step by step, real organized" fashion. He explained, "I like neatness for the most part. I'm not terribly strict about it." (77M.3.5)
He also expressed strong sentiments regarding completing assignments or learning tasks that he’s begun. “It’s irritating not to, I think, for me.” (79M.3.5)

Mike’s responses, taken collectively, indicated a preference for analytic over global processing strategies. However, it was not expressed strongly or consistently in the majority of his responses. Mike’s LSI profile indicated that he did not have strong global or analytic preferences. None of his strong preferences were of elements considered to be characteristic of global or analytic preferences.

Dan’s responses included preferences for global and analytic styles. He too, expressed a need to bring closure to learning tasks. “I would prefer to do them all at one shot and get them done. I don’t leave things unless I have to. I tend to think about them a lot. I like to have closure.” (39D.2.2)

He also referred to his preference for factual information when learning, initially and then spoke of valuing conceptual understanding even more so. “I like to know how something works. I also like to know that in detail, facts. It’s hard for me to pick one or the other, but if I had to, it would be the understanding.” (27D.1.6)

In another place Dan explained the importance of details and major concepts when learning new information in a lecture situation. He indicated that both are important, although he first seeks understanding of concepts and then completes the details.

Both, I like working with details tremendously, but I also like the big picture. In other words, in a lecture or something I try to understand the main, big picture first, and then I concentrate on the details. I like to do the details. (40D.2.2)

He also explained that when he studies, he begins with major concepts and then works toward mastery of the details. “…like I said, tonight I’ll study the big concept,
tomorrow the details, the next day I'll review the details. Sort of that strategy, rather than just jump into the details right off the bat.” (29D.1.7) He also explained that he plans his study time and breaks learning tasks into chunks of time, rather than studying for an extended period of time immediately before a test or quiz.

Dan's responses tended to be slightly more analytical than global. For example, in speaking of how he prefers to structure learning tasks, Dan expressed a preference for step by step and sequential ordering. “Like if it's random, then I feel a little disjointed.” He also explained that he prefers to have a plan rather than allow learning experiences to be open-ended or spontaneous. He plans his study time and uses lists to lay out his study schedule. (50D.3.1)

In describing a teacher he had in high school whom Dan considered to be very effective, he said the following.

He was very challenging, it was not a blow-off class, you had to work hard and think about, and he always challenged you to make you think of things in a different way. Rather than by rote memorization, he really made you think. And he made it exciting to learn... For example, there were problems that had a little different twist on it than you normally had to work with, and you really had to think independently to figure out. And he'd get very excited about it, and talk about it in class and he made it interesting. He made you want to push yourself hard, to learn and, to see if you could rise to the occasion. (63D.3.3)

Dan explained in this response how it was the process and problem solving mental activity that was so valuable to him, more appealing to global learners than to analytics. However, throughout his responses, Dan gave indicators of his ability to be flexible and draw on both analytic and global processing strategies.

Dan's LSI profile included preferences in two elements that were considered to be global processing preferences, those for low light and need for intake. Dan's responses to the grounded survey on global and analytic statements indicated a slight leaning
<table>
<thead>
<tr>
<th></th>
<th>Mike</th>
<th>Dan</th>
</tr>
</thead>
<tbody>
<tr>
<td>global</td>
<td>I(balanced)</td>
<td>I(slightly)</td>
</tr>
<tr>
<td>analytic</td>
<td>I(balanced)</td>
<td></td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

Table 5.24: Psychological LS Elements of Mike and Dan

toward global statements, but not enough to indicate a strong preference, as shown in Table 5.24.

5.6 Summary of Twin Learning Style Data

Tables 5.25–5.30 summarize data for all of the twins combined under the subheadings of the elements of the Dunn learning style model. It compares both interview responses and LSI profile scores. Interview responses that were common to both are shown using the “I” letter. Dunn profile scores that were common to both are shown using the “D” letter.

5.7 Concluding Remarks on the Qualitative Data

The data contained in Tables 5.25–5.30 indicate that identical twins have distinct and individual learning style strengths. Even though they often may have a few common strengths, the majority of their preferred ways of learning new and difficult information are not shared between twin siblings.

In the case of Carl and Jay there was one common LS preference for the kinesiologic modality, and seven LS preferences where only one of the twins had shown a
<table>
<thead>
<tr>
<th></th>
<th>Ann and Jill</th>
<th>Jay and Carl</th>
<th>Mike and Dan</th>
<th>John and Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Light</td>
<td>I</td>
<td>D</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Temperature</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.25: Environmental Elements for All Twins

<table>
<thead>
<tr>
<th></th>
<th>Ann and Jill</th>
<th>Jay and Carl</th>
<th>Mike and Dan</th>
<th>John and Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Groups / Peers</td>
<td>I(Dislike)</td>
<td>I(Dislike)</td>
<td>I(Dislike)</td>
<td>I(Dislike)</td>
</tr>
<tr>
<td>Authority Figure</td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.26: Social Elements for All Twins

<table>
<thead>
<tr>
<th></th>
<th>Ann and Jill</th>
<th>Jay and Carl</th>
<th>Mike and Dan</th>
<th>John and Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Persistence</td>
<td></td>
<td></td>
<td>I(Very)</td>
<td>I(Very)</td>
</tr>
<tr>
<td>Responsibility</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td></td>
<td></td>
<td>I</td>
<td>I</td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength
D = Strong Preference According to Dunn LSI Profile
Description given in parenthesis

Table 5.27: Emotional Elements for All Twins

148
<table>
<thead>
<tr>
<th>Auditory</th>
<th>Ann and Jill</th>
<th>Jay and Carl</th>
<th>Mike and Dan</th>
<th>John and Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>I</td>
<td>ID</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Tactile</td>
<td>I</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

**Table 5.28: Perceptual Elements for All Twins**

<table>
<thead>
<tr>
<th>Intake</th>
<th>Ann and Jill</th>
<th>Jay and Carl</th>
<th>Mike and Dan</th>
<th>John and Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Day</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

**Table 5.29: Physiological Elements for All Twins**

<table>
<thead>
<tr>
<th>Global</th>
<th>Ann and Jill</th>
<th>Jay and Carl</th>
<th>Mike and Dan</th>
<th>John and Jeff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytic</td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
</tbody>
</table>

I = Significant Finding from Interviews, but not necessarily a LS strength  
D = Strong Preference According to Dunn LSI Profile  
Description given in parenthesis

**Table 5.30: Global / Analytic Elements for All Twins**
strong preference. John and Jeff shared six LS strong preferences in the elements of: authority, auditory, intake, dislike for late morning and a preference for evening and afternoon as time of day. There were five other LS elements that were not shared by John and Jeff.

Even among perceptual modality elements, one twin’s preference for initially being presented information through one perceptual sense, does not indicate that twin’s sibling’s strength. In cases where twins do share a common perceptual strength, one or both may have different secondary perceptual strengths. Previous studies (Bouchard et al., 1990; Lykken, 1982; Salzano & Rao, 1976) that indicate that identical twins are very similar in personality and academic ability should not be taken to indicate that twins prefer to learn in the same way.

The information that individual participants gave about how they studied (such as Dan’s reliance of tactual modality by using a small scribble notebook, or Jill’s early insistence on relying on adults for answers rather than ask her twin sister for help, or Jay’s sleep-study cycle for learning massive amounts of information in short time periods) were very revealing. These specific traits and influences on their styles of learning were not shared by their twin siblings. Even though these twins often considered their academic ability to be very similar to that of their twin sibling, the data indicated that they had different learning style strengths.

The data presented in this chapter may be summarized in the following statements:

- Monozygotic twins do not share many of their learning style strengths of the elements in the Dunn model.

- Even among perceptual modality strengths, one twin’s strength or weakness was not consistently that twin’s sibling’s strength or weakness.
• Descriptive accounts of each individual of a twin pair varied. Although many responses were similar, there were many responses and accounts of one individual that were not shared or even described as important by their sibling twin.

The information presented in this chapter complements that which was presented from quantitative comparisons in chapter four. There are general and specific instances in how the learning styles of MZ twins as a group, and when compared to those of DZ twins, are different.
CHAPTER 6

QUALITATIVE ANALYSIS: EMERGENT THEMES ACROSS THE CASES

6.1 Introduction

The qualitative aspect of this study allowed the researcher to collaborate with the participants resulting in the discovery of several themes regarding learning styles and the experiences of identical twins. The following sections explain the emergent themes that evolved from the interviews of the eight monozygotic twins. These themes were pivotal and had influenced the LS of these twins. The five themes that emerged are each worthy of additional research.

6.2 Emergent Themes from Interview Data

Five themes emerged in the course of the interviews. Many of these themes exposed other factors that could impact one’s individual learning style. The interview format was conducive to exploring some of these themes.

The strongest themes to emerge were:

- Early positive non-formal learning experiences
- The role of competition among twins
• Twin recognition and its impact on learning

• The desire and need for individual recognition and identity

• The awareness and use of LS strengths in their study strategies.

6.2.1 Theme One: Early Positive Learning Experiences in Science

Many of the responses and reflections on learning focused on the positive involvement of individuals in activities such as scouting, educational family vacations, and parental or adult guided extra-curricular activities.

Jay and Carl both mentioned the positive influence scouting had on their interest in nature and science. They were part of a small, active troop headed by a very educated and patient scout master. The scout master worked at Chemical Abstracts, an organization involved in the abstracting and information services of chemistry research. Jay and Carl spoke of their scout master as one who was very patient and able to answer questions intelligently.

Jay and Carl also spoke of the times their parents would take them on cross country vacations where they would camp and enjoy natural settings. Their appreciation of nature and camping was emphasized. Upon completion of their undergraduate degrees, Jay, Carl, and a mutual college friend spent approximately one month camping and hiking in national parks in the western United States.

Mike and Dan recalled the educational vacations their parents had planned when they were younger. They explored sites of historic and educational significance. Mike and Dan expressed that they developed an interest in geography and travel, as well
as an interest in maps and map reading, from such experiences. They too continue to explore new cities and enjoy the accumulation of geographic information and trivia.

Another informal experience that deeply impacted Mike and Dan in junior high school was their father’s involvement in a serious auto accident that required many years of rehabilitation and medical treatments. In their contacts with physicians and medical personal they were exposed to the medical profession. The experience was mentioned as pivotal in helping them decide to study medicine following undergraduate college.

For Ann and Jill there was the importance of being reared with certain underlying “expectations” held by their family, school, and social community. They each mentioned the impact of growing up in a parochial school environment where everyone was expected to do well, achieve, and eventually attend college. Jill summarized the impact of such expectations in the following quote.

I think more than anything, just a sense of expectation. It was just expected of me to be a..., to master certain things or take certain classes, and to do well. It was never a question of having an opportunity to fail, or to not be able to be expected to do it.... Everybody I went to high school with, was really taking courses preparing you for college. So I remember, until I got older, I met people that never went to college. Wow! I never even thought that there were choices other than that. It just never dawned on me. (6Ji.1.2)

Ann and Jill were often helped with their homework by their father who was a mechanical engineer by profession. Ann and Jill also mentioned that both their parents were practical in their approaches to school and work. Their parents spoke of the importance of getting an education in a field that could help one attain employment and a stable income.
At one point Jill spoke of her interest in possibly preparing to become a marine biologist, but she stated that she was dissuaded by her parent's comments. She stated that her parents thought that she couldn't really find employment very easily in marine biology research. Jill explained,

I really think I got talked out of it. There weren't jobs and you couldn't really do anything with that type of thing. My parents are both very, very practical, and they (think) 'don't get a job that you necessarily enjoy or are interested in. Get a job that you can be successful at and you can do for 45 years. Have a decent standard of living and retire.' (53Ji.3.2)

In fact both Ann and Jill expressed an interest in biological topics and even now find topics on viruses and similar biological issues of interest. They are also interested in mysteries or detective forensics and enjoy such thrilling novels and stories.

Ann mentioned that her early school environment endowed a sense of responsibility upon students, as well as expectation. "The whole environment there...I think they give you more responsibility but because of that, you achieve more...I guess there are certain, expectations, to achieve academically." (13A.1.4)

Jeff and John recalled the impact of their mother and father on their early education. They both mentioned the point that their parents emphasized the value of a good education, especially a college education. Although both parents had not graduated from college, and were financially successful, they would often comment that an education is one achievement that can not be taken away once one has achieved it. They also stressed that an education can help you transition into other jobs if the economy changes.

Both Jeff and John also mentioned the role their mom had in introducing them to the hospital and medical field. They would often visit their mom in the hospital where she worked as a secretary-receptionist. On such visits they would witness patients and
nurses interacting, and they would explore and learn of medical procedures informally. Their mother would on occasion also share interesting stories of hospital events with John and Jeff upon returning home from work.

Another early informal learning experience with the medical and hospital community began when at age fourteen John developed diabetes. He was hospitalized for a time and had to learn to deal with dietary restrictions. It was a learning experience for both him and Jeff. They learned firsthand the care and attention given by nurses and dietitians. They looked up to them.

What appeared important in the interviews on informal learning was the way in which parents, the school community, or local extracurricular groups had positively influenced and fostered an appreciation of learning. Although this interest in learning and an interest in science was often guided by parents, it had been further re-enforced and expanded by other non-formal learning experiences.

6.2.2 Theme Two: The Role of Competition Among Twins and Their Learning

Another important theme that emerged was that of competition between the twins. The competition was, in these four pairs, often termed a ‘healthy competition,’ or positive sense of competition. In many instances one of the twins would say something like, “if I can’t achieve or reach the goal, at least I hope my twin sibling will.” They expressed satisfaction in seeing twin sibling succeed.

Two pairs of the twins interviewed had similar comments on the role of competition in their academic and non-academic lives. John and Jeff as twins, and Mike and Dan as twins frequently compared grades and scores. Both pairs considered this to have a motivational and positive influence on their academic endeavors. Both pairs also
mentioned that each twin knew the ability of himself and their sibling and therefore would hold each other accountable for reaching their fullest potential. Many times such competition would result in averages or scores a few points, or tenth’s of a point apart.

Mike explained the role of competition here.

I think it’s all me. I don’t think it’s anything external pushing me. I would say growing up with my brother, I think competition between us is a big part. There’s nothing else... I think we compete at everything, but I think we’re different from a lot of people in that we compete in a friendly manner. If he’s done something, (or) if I don’t learn something, we compete a lot and try hard, but it’s not a malicious sort of thing. (14M.1.3)

His brother Dan echoed a similar sentiment beginning with his description of the sense of competition.

If within a few points, it wouldn’t matter. If we both did roughly the same, but if one of us did a lot better than the other one, then that was a big issue. It didn’t happen very often, but I think that was partially motivation too. If he did better than I did, it would make me want to work harder, or vice versa. (7D.1.2)

Dan continued to explain that the competition was “very severe,” at times.

If he succeeds I’m happy for him, as long as I don’t fail in the process. If that makes any sense? I’m happy for him if he succeeds, but if he succeeds, that makes me feel like I need to also. (7D.1.2)

Mike explained that the sense of competition between him and Dan was more important than the competition between him and his fellow classmates.

Fortunately, we’re very close in abilities, and we’re always trying to beat each other, and more about beating each other than the rest of the class... It wasn’t malicious, you know, we didn’t hate each other or fight. It was a healthy competition, and I think it helped us do well. (39M.2.1)
John and Jeff share a similar sense of competition in academics and when playing sports. John reported that there were times in high school wrestling when their coach wouldn’t let them wrestle each other because “it would be a wild brawl every time we met each other on the mat.” (12Jo.1.3) He continued to explain, “There’s a lot of competition between us, even now that we’re in college. He’s got a 3.7 and I’ve got a 3.6, usually only a tenth of a point away, but we’re pretty close.” (12Jo.1.3)

Jeff commented that at times the competition is almost too competitive, with John.

We compare against each other and stuff, but if I were to get an ‘A’ and he were to get a ‘C,’ I wouldn’t feel like I, I kind of feel like we both didn’t do to our potential. If he would get an ‘A’ and I would get a ‘B,’ that would be fine, because that’s not too far apart. (9Je.1.2)

Carl and Jay didn’t compete with each other in academics but did in sports, especially when playing tennis. Jay explained, “But in school, we’ve never ever been competitive in school. I mean ever. I can’t even remember a time when we would compare grades, like on tests or whatever... It never was an issue ever, with us.” (27J.2.2)

Carl confirmed that although he and Jay are very competitive on the tennis court, they do not compete with each other in academics. However, in school, especially in high school, teachers and school counselors indicated that they would almost encourage a sense of competition between them. In college, some of their friends would often ask if they were competitive in their academic subjects.

For Ann and Jill the competition factor was unique and pivotal. Early in elementary school Jill spoke of the time at which she decided to excel at subjects that her sister did not. She also recalled being compared to Ann by their mother. She began
by responding to the question whether there was a sense of competition between her and Ann.

Yeah, I think probably a little bit... I don’t know if it was so much from our perspective, as from my parents, at least my mother’s. I remember being compared a lot, and like Ann getting into National Honor Society before I did or getting some honor or something. That being kind of a big deal, kind of pressure on me to accomplish that... I think in a way it was intended to be a motivator. But everything we’ve done has always been kind of, if she was good at something, I really didn’t try to be good at that thing. And so school, it was like she was really good at math and science, and I was perfectly willing to be horrible at that, and be good at other subjects... I think we always tried to be conscience of that, not like excel in the same thing, to do our own thing so we wouldn’t be in competition with each other. (27.Ji.2.1)

Jill continued to explain that much of the comparing was done by her teachers and other adults.

You were always compared. But I think we tried not to be... We were so much viewed as one entity, that if she was good at something, I should be good at it... I think it motivated us to try and be different (emphasis on different) so we would have our own identities, and we did that in a lot of different areas, including academics... And I always had in my mind feeling, ‘Oh, she’s smarter than me in math, in science, and all that kind of stuff.’ But I don’t know how much of that was really true and how much of that was just kind of self-imposed. (27.Ji.2.1)

Ann responded similarly with comments on how she was compared with Jill. She mentioned times when adults would ask, “Well, who’s faster? Who scored more points? Who can beat who? Who’s better in school? It’s all there. It was never in a mean spirited way, nothing like that.” (36.A.2.6) Ann too, recalled her mother treating them as a unit, assuming that if one choose to go someplace or expressed a certain preference, that the other would choose the same.

Ann and Jill’s sense of twin competition actually resulted in actions and decisions that were intended to avoid or lessen that sense of competition. Ann later commented
that because Jill was often the one to try her own way of doing things and not follow the way that was often expected or outlined, she was admired by Ann.

Jill commented,

I think Ann is, I realize this more lately than I ever did growing up, I always looked at her as the smart one, the accomplished one. I thought that she was better than me. And it didn’t bother me, that was fine. And as we’ve gotten older, I realize that she kind of looks to me, more than I would’ve ever thought she would. That maybe she’s, has more insecurity than I thought she did. Or even maybe looked up to me, just because I’m the kind of like the, the bum of the family. Everybody else gets jobs and she’s very conservative,...has to have that security, that stability, and doesn’t like taking chances. And then, they just always teased me about being like a ‘bum.’ (68Ji.3.6)

Even though the air of competition was evident in three of the four pairs of twins in this study it resulted in different outcomes and responses. And although it was generally a positive motivational force among the twins, it did have unexpected outcomes in the case of Ann and Jill by influencing their academic interests.

6.2.3 Theme Three: Twin Recognition and Its Impact on Learning

Another major theme that emerged was the impact being recognized as a twin had on how each individual was perceived by peers, teachers, and others associated with the school community. In some cases the situations discussed in the interviews were mentioned as casual exchanges. At other times, such interactions between the twins and the school community were discussed as being very important to them and their academic concerns.

Jeff mentioned that he liked having John as his twin brother because it was motivational. He also recalled times when he could approach his brother with academic questions if he ran into problems, even though he emphasized that they did not study
together. Jeff and John would also compare their notes at times to see that they had completely copied the information from class lectures. Jeff went so far as to say that studying in college is easier for him because John too is studying nursing, and together they work as lab partners and can motivate each other. Since John and Jeff often spend most academic weekdays together, they often choose to be apart, each with their respective girlfriends, on the weekends.

John mentioned an experience in elementary school when he and his brother were placed in separate kindergarten classes. He felt that it was a shock that he was so accustomed to being around his brother and then he was separated to the point of hardly seeing him at all during the day. He described it as follows.

In elementary school they kept us pretty separate. I’d be lucky to see him once a day. In elementary school, it was more important that I did see him, and I didn’t. But in high school, I was more independent... In high school it really didn’t matter to me that much, as much. I probably saw him more than I probably wanted to. (48Jo.2.4)

John and Jeff also mentioned the importance of being motivated by each other. They valued the opportunity to be challenged by teachers too, and would rather have felt like they learned a great deal from a course or teacher, rather than have achieved a high grade but feel as if they did not learn much. Jeff commented that having his twin brother develop and then deal with diabetes, was instrumental in helping Jeff decide to enter nursing as a profession.

John and Jeff also explained the impact that being a twin and being competitive had on their educational success. John recalled that being a twin had affected his ability to learn in the following way. “Like if he messes up, he has to answer to me, and if I messed up and he doesn’t, like it’s, ‘Why’d you do that?’ We just motivate each other, try to keep each other, I guess, ‘in line.’” (54Jo.2.6)
Jeff commented similarly when asked if he thought being a twin had affected how he learns or how good of a student he was. “Probably in the sense that, for one, we’re competitive. I’ve actually tried harder probably, to understand the concepts. And in another sense, yeah probably, because we have courses where we can ask each other...that gets us more involved.” (50Je.2.5)

Carl explained that being a twin had advantages in increased recognition by teachers and professors, which could result in personal attention. He explained that, “because it can contribute to name recognition and attention by teachers, professors, and peers; that can help you ‘get known.’ I think it really did help me learn.” Carl explained that being a twin is a quality that can set a student apart from other students. He explain that, “We’re very recognizable on campus, by the professors, and so I really think that’s an advantage because, in the classroom environment, they know your name. They get to know you more, and people are always curious about twins.” (89C.3.11) Again the emphasis is on individual recognition and how being a twin may affect that recognition.

Carl explained that when he went to graduate school apart from Jay, things were different because he was, “Carl, not twin Carl,” and no one there would even know he was an identical twin unless he chose to reveal that to them. It was the first time in his education that he had not been attending classes in the same school or college as Jay.

Jay explained the effect of being a twin on his education as being “a little” helpful in cases such as those where he needed help in chemistry and could go over to ask Carl questions, since that was Carl’s undergraduate major. He also explained that he and Carl can communicate rather easily, using few words which can be a great help in
explaining concepts or analogies to each other. Some of their friends would sometimes
listen to their brother to brother conversations and say, “What are they saying?”
Some friends called their communication patterns the “information highway.”

Carl explained it as,

We’re very much alike... I’m able to much more efficiently bounce ideas
off Jay than other people. And he’s always someone I can go talk to...
He knows where I’m going with things, much more efficient that way. We
know each other’s perspective on things, and we’re close in that sense. I
can explain to Jay faster than anyone else. I can say a few words, and I
can get him to understand something in less than a sentence, usually. I’ll
make some point, and it will just click. (92C.3.12)

Both Dan and Mike responded to the question of the impact of being a twin on
their learning with some hesitation and initially by saying it had little impact on their
academic development. They later explained that they knew their scholastic abilities
and used a positive sense of competition to help motivate them in their learning.
Since they both had similar academic abilities, it was a “very good competition, and
very healthy.” (72D.3.5)

Ann and Jill commented that their peers often expected them to be competitive
in school. And that they rebelled against being labeled “the same.” They would even
at times strive to be different intentionally.

This theme speaks directly to the need for educators and parents to realize the
ways in which we expect twins to be similar and how as such they may be treated.
Although twin recognition can have its advantages, it can also be restrictive to the
development of individual identities when people expect twins to be similar and com-
petitive with each other.
6.2.4  Theme Four: The Desire and Need for Individual Recognition and Identity

John and Jeff expressed their need to be apart from each other on the weekends. They prized the time spent with their girlfriends and their girlfriends’ families partly because they were seen as individuals there and not constantly associated with their brother. The time away from each other was valued because most of their academic day and work day was spent together. Jeff mentioned times when his brother would not be mentioned around his girlfriend’s home for the weekend, and how being with her family was a chance to be seen as an individual. Jeff explained it as follows.

My girlfriend and her mom and dad, yeah they met my brother, sure. But, I just don’t feel they knew him nearly as good as they know me. And they really don’t talk about him when he’s not around. When he’s around sure, but I feel like I’m Jeff there. But actually they never mention my brother, so I’m definitely my own person there. But when I’m around the house (his own family’s house) everybody knows me and John and how we’re alike and our differences and so, I feel like I don’t have my own identity as much around my house as I do at Mary’s (his girlfriend’s house). (53Je.2.6)

John too spends weekends at his girlfriend’s home and with her family. He mentioned that it was good to be apart from Jeff because they spend a lot of time together during the week at the hospital, on their jobs working for their father, or in their nursing courses.

John and Jeff also spoke of the desire to be seen as individuals by their parents and their family. They recalled times in their youth when they were often referred to as ‘the twins’ and where both of them would be blamed even if only one of them was actually responsible. John explained it this way.

If I do something wrong, my parents even did this to me, it’s ‘the boys.’ He’d get blamed too. I don’t know if it’s like that at the hospital...if I
do something good or if he does something good, my boss might tell my mom, ‘the boys...,’ and I had nothing to do with it, it was all Jeff. And it’s like that at home, too. If I do something wrong, we both did it. And if he did something wrong, we both did it... I wish I had my own identity, you know, if I had my independence. If he was real bad, or into trouble or something, then it would really bother me. But as long as we stay out of trouble. But we have a double chance of being blamed if we do get in trouble. (50Jo.2.5)

Sometimes people wouldn’t even bother to try to call John and Jeff by name and even around the hospital would consider them as a unit, not even trying distinguish one from the other. Jay and Carl described this same phenomenon with some regret. Mike and Dan mentioned it as well, and would sometimes even stagger their entrance into the hospital where they were fulfilling medical school rounds. That way they could call less attention to themselves and be considered individuals rather than as ‘the twins.’ In fact, Dan and Mike even had some close friends still not recognize them for their individual differences even after knowing them for years. That really irritated them. Jill and Ann also mentioned that they were often mistaken for having the same interests.

Jeff emphasized that around the hospital he and John are referred to as ‘the twins,’ which can at times be annoying, especially when fellow workers won’t even make an attempt to distinguish between them. Jeff explained, “...and I really don’t like that at all. I like to be called Jeff, and him, John. Even if they can’t tell us apart, I would rather they guess and get it wrong.” (51Je.2.5)

This feeling of wanting to be identified by name and for their individual qualities was emphasized by each of the twins interviewed for this study. And many times, the same sentiment was expressed; that they would prefer to be called name, even if it was their twin sibling’s name, rather than be referred to as a unit.
Jay and Carl also emphasized the desire to be called by their individual names rather than be referred to as ‘the twins.’ For them being compared was more of a problem when they were younger, but now they feel they are not compared as much. They also said they’d rather be mistakenly called by their brother’s name than by a collective name. Jay explained that people often are so apologetic upon getting their names mixed up, and to them it’s no big deal. They still prefer to have people try to distinguish them from each other.

The issue of individual identity and choice came up when Jay and Carl were deciding where they’d attend undergraduate college. Jay selected from among many possible colleges before Carl. Carl eventually selected the same college, but not before considering what others might think of his decision as being influenced by Jay’s decision. Carl finally figured that if it was his top choice and he wanted to attend that college, it would be unwise to let what other’s think interfere with that. Even though Carl and Jay attended the same college, they recognized their need for their own individual space, and they respected that need.

Jill and Ann established their individual identities early in their schooling when they began excelling at different subjects. This was expressed by Jill in her decision to pursue subjects other than math and science which were Ann’s forte. Being compared and considered “one entity” actually motivated them to be different.

Another important factor contributing to the choice to be different was the size of the elementary and secondary schools that Ann and Jill attended. Ann explained,

Our school was so small, like in high school, anybody who was going to take algebra one...would be in the same class. Even if you weren’t in the same class, same physical class, you were taking it the same grading period. It was always the same instructor. We had one instructor that
taught physics, so I think it was just natural, we were always compared, in everything. (65A.3.4)

Both Ann and Jill expressed resentment for the times they were considered a unit or for times when it was assumed that their preferences would be similar.

Jill remarked at one time that she would ask adults for help before asking her peers or asking Ann. She remarked,

I remember even with Ann, I would like, not even go to her...and when I would ask her to help me, I’d go, ‘That’s not right.’ And I’d still ask my dad. I trusted adults more than other kids cause I’d think, ‘Why would they know more than me?’ (13/14Ji.1.4)

From these quotes and interactions one begins to see that the need for individual attention and the realization of a separate identity that is part of the twin relationship. And such a relationship can influence each sibling. Attempts to establish one’s individual identity can also be varied and have a lasting impact on academic choices as well.

6.2.5 Theme Five: These Twins Who were Successful in School were Aware of Many of their Learning Style Strengths

In the interviews it was apparent that these individuals recognized and utilized their own personal learning style strengths. They were able to clearly delineate strategies and factors that were beneficial in improving their level of concentration when learning new or difficult information.

These individuals were clearly successful in school and had developed a fondness for learning which relates to knowing and using one's learning style strengths. On several instances they would mention specific strategies, such as Dan’s pocket notebook which he would use to help him tactually process detailed information, or Jay’s
habit of being in a comfortable and informal environment where he could be more productive. They were able to explain specific factors or tactics they had found helpful without hesitation.

They drew upon their experiences as students, in both formal and non-formal environments, and had made use of their learning style preferences. They were able to define those learning style elements that were least productive for themselves, such as group work or intake while studying.

6.3 Summary and Comments

The preceding descriptive accounts give evidence that monozygotic twins do indeed exhibit some common themes relating to their educational experiences and their individual learning styles. Also, identical twins exhibited different strengths among their learning style elements. The discovery of such differences may appear contrary to many earlier findings that emphasized the similarities of identical twins in most physiological and psychological inventories.

Those themes that appeared across all cases of these four pairs of monozygotic twins were summarized as:

- Early positive non-formal learning experiences
- The role of competition among twins
- Twin recognition and it's impact on learning
- The desire and need for individual recognition and identity
- The awareness and use of LS strengths in their study strategies.
CHAPTER 7

DISCUSSION AND FUTURE RESEARCH

7.1 Reflections on the Learning Styles of Twins

In the course of this research the researcher uncovered rich descriptions and specific details regarding learning style elements. First, by employing qualitative research methods to investigate the learning styles of twins many rich and varied vignettes emerged. Such shared experiences illuminated specific elements of learning styles. Secondly, the learning styles of these eight monozygotic (identical) twins do vary in ways previously not considered. In many cases, one twin’s strength in a particular category or element was not their sibling’s strength. A third finding was quite unexpected. Several themes emerged from this study which indicated several intricate relationships that can influence one’s learning style strengths. The emergent themes that appear to have been affecting these eight individuals were:

- Early positive non-formal learning experiences
- The role of competition among twins
- Twin recognition and its impact on learning
• The desire and need for individual recognition and identity

• The awareness and use of LS strengths in their study strategies.

7.2 Revisiting the Research Questions

The initial research questions investigated the following:

1. What are the learning style strengths of monozygotic twins and how do they compare?

2. What do the qualitative data reveal about the learning styles of monozygotic twins?

3. Do monozygotic twins have similar learning styles as a group when compared with dizygotic twins?

The first research question dealt with the learning style strengths of individuals who were monozygotic twins. That question was considered by comparing the categories of LS elements in the Dunn model. The subcategories of perceptual modalities (including: auditory, visual, tactual, and kinesthetic) were also compared for each pair of twins.

The descriptive quotes and the tables in Chapters 5 and 6 highlighted the specific strengths of the twins in this study. It was evident that learning styles strengths of individual monozygotic twins and their sibling's differed qualitatively. One twin’s LS strength was often not a LS strength of their sibling twin.

The perceptual strengths of monozygotic twins were also infrequently matched with those of their sibling twin. When they did match, there were often other perceptual strengths that one twin had that their sibling did not share. None of the
four pairs of these monozygotic twins shared all of their perceptual strengths, either according to their Dunn LSI profiles or their responses to interview questions. And although many of their responses to perceptual modality items were often similar, the degree and consistency of emphasis on those items varied significantly.

The analytic or global elements of one twin were not shared by their sibling twin. In the case of these eight individuals, none of the global or analytic elements of one twin matched more than one global or analytic preferences of their sibling twin. The one matching occurrence was in the element of intake for John and Jeff. This would appear to support the idea that global and analytic preferences are not necessarily shared among monozygotic twins.

The second research question led to a wealth of descriptive data. The use of interview methods allowed the researcher and the participants in this study to co-explore some issues and themes arising from discussions about LS elements.

Five themes were identified in the course of the interviews and were revisited frequently. These themes were important because they were evident across each of the four pairs of twins and were emphasized on several occasions. The theme of positive early experiences was returned to frequently in the interviews. Jay and Carl, Dan and Mike, and Jeff and John reported that their early informal educational experiences had much to do with their decision to value education and to decide to take career paths in science related fields. In a different way, but still of note, was the description and emphasis that Jill and Ann gave to the important “expectations” they experienced throughout their elementary and secondary school years. Ann and Jill also emphasized the ways their parents valued education and how their father had helped them with their homework.
The themes of twin recognition and twin competition were discussed in the interviews too. It became evident that being recognized as twins had its advantages and disadvantages. The expectation to be in competition often came from teachers and peers, as described by Jay and Carl. However, each of these individuals described the competition as being more positive than detrimental to their attitudes toward learning. In the case of Jill and Ann the competition was described as one influence that made Jill decide to excel at different subjects than Ann. In the case of Mike and Dan, as well as in the case of Jeff and John, the twin competition was described as motivational in their academic pursuits.

The fourth theme that was expressed emphatically (and was most surprising to the researcher) was each twin’s description of their need to be recognized for their own accomplishments and have their own identity apart from their sibling twin. It was surprising to hear that three of the pairs of twins decided to attend the same colleges and had to find ways to satisfy their needs for individual space. Mike and Dan described how even in medical school they would make sure they didn’t use the same hospital entrance or walk in together. This helped others see them as individuals. Mike and Dan also described how frustrating it was to have their close friends still not recognize them as individuals with distinct personalities and preferences. Each of the individuals spoke of the constant need to avoid being lumped together as “the twins,” preferring instead that people attempt to use their given names even if they are mistakenly called by their sibling’s name. Being called by their sibling’s name was preferred to being called or referred to as “the twins.” This was true of all four pairs of twins.
The fifth theme to emerge was how each twin was able to identify some of their strongest LS preferences and they were incorporating them into their personal study strategies. All of the individuals interviewed were able to quickly describe the elements and strong preferences of their learning styles.

The third research question compared qualitative data with the quantitative data obtained from the Dunn LS inventory for a larger sample of twins, including a sample of dizygotic twins.

The quantitative analysis yielded some helpful insights that supported some of the qualitative findings. The samples of MZ and DZ twins indicated that twins, in general, share very few of their LS strengths. This supports the findings in the qualitative study. In addition, the quantitative analysis showed that MZ twins share more strengths than DZ twins and have fewer discordant strengths.

In other words, both the numerical data and the qualitative data indicated that learning style is quite variable within the group of monozygotic twins. It became evident that knowing the LS strengths of one identical twin did not enable one to predict the LS strengths of that twin’s sibling. Therefore, caution should be exercised by adults, teachers, and parents to recognize the individual learning preferences of monozygotic twins.

7.3 Implications of the Findings of this study

The implications of the results of this study can be explored in these ways: implications for teachers and administrators; implications for parents; and implications for twins, their peers, and their siblings.
7.3.1 Implications for Teachers and School Administrators

Teachers and school administrators should consider and recognize the importance of twins and their different learning styles when making pedagogical decisions. Opportunities to learn according to one's learning style should be recognized and supported. Because identical twins are similar in many ways, efforts should be made to keep from assuming that they prefer to learn in similar ways. Twins in the same class should be given opportunities to learn according to their LS strengths. In fact, if MZ twins have varied LS preferences, then it is probable that unrelated students have varied LS preferences as well. Efforts should be made to honor such LS strengths and preferences of all individuals.

Teachers and administrators should also refrain from making school-wide policies regarding twins and their learning without considering individual cases. Twins and their parents should be included in discussions that involve educational decisions even at an early age.

Teachers should also be aware of how peers may expect twins to be similar. Peers may also expect twins to compete and to compare their grades, abilities, and academic progress. Such peer pressure can be counter-productive and may actually hinder learning. Therefore, efforts need to be made to view each twin as an individual rather than expect them to be alike in how they learn.

7.3.2 Implications for Parents

Parents should be advised to provide learning experiences apart from school since all of the individuals interviewed spoke favorably of the role such non-formal learning
experiences had on their academic development and acknowledge their learning style strengths.

It is also advisable that parents recognize and honor learning style differences in their twins and offer them options in organizing their personal study space. Another recommendation is to allow twin siblings choices and opportunities to make decisions regarding academics. Twins should be accepted for their individual learning strengths and not be expected to have similar LS preferences.

Finally, twins’ preferences should be considered when making decisions regarding academic choices. School wide policies regarding the separation of twins upon entering school or how to handle similar academic matter should be handled on a case by case basis. Twins, their parents, teachers, and school administrators should all be part of such decisions rather than held to inflexible rules. Even young students should be involved in these preliminary discussions.

7.3.3 Implications for Twins, Their Peers, and Their Siblings

Individual twins should be given opportunities to engage in learning experiences of their own choosing with and apart from their twin sibling. Twins often require individual space and may need different study environments. Such considerations should be respected and accepted.

It is also common for twins to require more time to develop their individual identities, hobbies, and learning styles as they progress through school. Such choices should be encouraged and expected. Twin siblings should feel free to express such individual choices to others.
The learning style strengths of twins should be respected by their siblings, their parents, their teachers, and all involved with their education. As was the case with the eight individuals interviewed, each twin may choose to study and work on academic assignments alone rather than together. Twins may also dislike being considered “a unit” by their friends and family, even if it occurs unintentionally. Peers and siblings need to understand that although identical twins may be alike in many ways, they deserve to be treated as individuals with their own preferences, especially in learning situations.

7.4 Limitations of this Study

There were several limitations to this study. First, it was an in-depth qualitative look at the learning styles of eight individuals and not necessarily representative of all or most identical twins. The participants were also very successful in their educational pursuits and may not be representative of all identical twins.

Each of the qualitative interview participants were of college age. This may have had some influence on the opportunity to find similarities and differences among individual elements of one’s LS. The influence of age and how one’s LS changes over time should be investigated further.

Time and the ability to easily locate twins to participate in this study was a limiting factor. This was a sample of convenience, although individuals were selected randomly from a pool of over one hundred possible participants that included individuals of various ages and academic backgrounds.
7.5 Summation Comments

This study has compared the learning style elements of four pairs of monozygotic twins using the Dunn learning style model. From qualitative data obtained from interviews, grounded surveys, and the Dunn LSI profiles several comparisons were made. These comparisons indicate that individual identical twins differ in their learning styles from their sibling twins. The data also indicated that one individual can have different learning style strengths than those of their sibling twin. Other significant themes were uncovered among the monozygotic twins interviewed. These themes were viewed as influential and warrant further investigation.

The quantitative results indicated that although monozygotic twins are more homogeneous in LS strengths as a group than dizygotic twins, individuals in either twin type share very few of their preferred LS strengths. Dizygotic twins shared more discordant (opposite) LS strengths than did MZ twins.

7.6 Discussion of Future Research Questions

This study indicated that there are themes and areas that need further exploration and research. Such themes as the need for individual identity and recognition or the role of non-formal learning experiences and their impact on learning should be investigated further. These themes have the potential to further our understanding of the characteristics and the influences affecting twins and their educational experiences.

Such themes should be explored further. There is a need for future qualitative research studies to continue the exploring of specific relationships of monozygotic and dizygotic twins and their learning styles. Perhaps specific areas, such as emotional elements, should be investigated using additional qualitative methods.
This research study is one that stands in contrast with studies indicating how similar monozygotic twins are as a pair and as a sample within the general population. It would be reasonable to consider that even though identical twins may share many similar experiences, personality traits, and academic test scores, they may indeed have unique learning style characteristics. Monozygotic twins do not necessarily learn in the same way, and in fact may often have distinctly different LS strengths.

7.7 Reflections of the Researcher

At various points in this study, the researcher made notes to himself and reflected upon the significance of the data collected. Using a personal journal and relying on his own learning style strengths, the researcher was able to identify significant consistencies and inconsistencies. These led to the presentation of data and the concluding remarks. This journal provided reflective information for the researcher.

Perhaps the most significant outcome of this research was the discovery that indeed the learning styles of monozygotic twins do differ in a variety of ways. These differences are often recognizable by the twins themselves, as well as from qualitative and quantitative data. This study cautions against the assumption that identical twins learn in similar ways or that they share the same learning style strengths.

It also became apparent to the researcher while conducting this study that qualitative methods do indeed yield a wealth of data which can illuminate patterns, strategies, and details that would not be uncovered by quantitative survey methods.

The researcher discovered that the methods employed in this study were suitable and successful in accumulating knowledge regarding the learning styles of twins. It was also important that the researcher constantly checked and verified these methods.
and themes with other researchers, as well as with the participants themselves who could provide essential insights. The researcher has developed a deeper sense of the extent and the demands of conducting qualitative research. The researcher is grateful to fellow colleagues, mentors, and various consultation services at The Ohio State University for their assistance and support in this research project.
APPENDIX A

EXPLANATION OF DUNN LEARNING STYLE PROFILE ELEMENTS

1. Sound:
   - Quiet preference: finds background or immediate sound a disturbance while studying or learning.
   - Sound preference: implies a need for sound as a mechanism for screening out other disturbances and for some, this sound is actually a help when learning.

2. Light:
   - Dim preference: shaded/soft light preference in work or learning environment.
   - Bright preference: direct light preference in work or learning environment.

3. Temperature:
   - Cool: Desire to have the room or body temperature cool when trying to work on school work or learning tasks.
4. Design:

- Formal: is considered to be at a desk/table and traditional desk chair.
- Informal: is the use of soft couch, soft chair, bed, or carpeted floor when learning.

5. Motivation:

- High motivation: implies a great degree of motivation toward learning tasks.
- Low motivation: implies low natural motivation toward learning tasks and such a person may benefit from having other incentives.

6. Persistence:

- High: willingness and desire to finish a learning task one has begun.
- Low: desire to complete learning tasks in shorter chunks with frequent breaks between.

7. Responsible:

- High: conforming to expectations, rules, or set guidelines are considered responsible.
- Low: non-conforming individuals prefer to have input in expectations and need collegial trust.
8. Structure:

- Wants structure: implies a desire to know specifically what is required to complete a task or assignment; this may include use of lists, outlines, sequential ordering of tasks, etc.

- Does not want: implies that one prefers their own way of structuring work; or at least having some choice in the way or order tasks are completed; feeling restrained by the way some tasks are ordered.

9. Sociological: Whom one chooses to work among:

- Alone.

- With an Adult, parent, teacher, etc.

- With peers, groups with students one’s own age.

10. Authority Figures: Whether one is helped by the presence of authority figures, parents, or teachers.

11. Several Ways: Whether one needs or prefers frequent changes in the social groupings when learning material.

12. - 15. Perceptual Modality Strength:

- Auditory: preference for hearing or listening, (especially using tapes, repeating words, and music).

- Visual: preference for seeing or using visual displays (including graphs, diagrams, etc.)
- Tactile (or tactual): hands on manipulation or involvement (keyboard, handling objects, writing, et al.).

- Kinesthetic: needs or has a preference for large motor/body actions and movement (ex: drama, movement games, skits, etc.).

16. Intake: Whether one needs healthful snacking or drinking of fluids during school work/learning tasks to remain focused.

17. - 19. Time of Day:

- Preference for morning (up to lunch time)

- Preference for afternoon (after lunch)

- Preference for evening (at or following dinner time)

20. Mobility: need to move around during or between learning tasks (may include pacing, swinging an arm/leg, or taking frequent breaks to move while continuing to think or prepare for learning tasks.)
APPENDIX B

SOURCE OF DUNN LEARNING STYLE INVENTORY

The Dunn Learning Style Inventories are available from and may be processed through:

The Midwestern Regional Teaching and Learning Center
1607 Robinson Road, S. E.
Grand Rapids, MI 49506-1799
APPENDIX C

INTERVIEW - OUTLINE QUESTIONS

C.1 First Set of Interview Questions

• Environmental:
  – When you study something new or difficult, describe the place you would go to study.
  – What are the surroundings like?
  – Describe the best place/room for you to concentrate on new or difficult information.

• Sound:
  – Are you aware of sounds around you while you study?
  – If yes, what do you do about them in order to concentrate?

• Light:
  – Describe the best lighting conditions for you to study.
  – Do you prefer sitting near windows?
- Do you prefer only a few lights on while you work on something difficult?

• Temperature:

- Some individuals prefer a certain temperature in which to work or be most productive. Do you find yourself sensitive to the room temperature when you study something difficult or new?

- Do you often find yourself putting on a sweater or peeling off layers of clothes to be more comfortable when you study?

• Design:

- If you had the chance to design the most productive work or study environment, what would it be like?

- When you work on new or demanding tasks do you prefer to work in a formal or more informal setting? A formal setting would be similar to traditional classroom settings with desks, tables, and chairs. While an informal setting is more likely to include easy chairs, places to recline, or use of the floor to study/work on tasks.

• Motivation:

- What has served as positive motivations for you when trying to learn something different or something that is complex?

- Can you think of one or two items that motivate you to learn about something new?

• Persistence:
– When you begin a learning task, would you consider yourself to be persistent?

– Thinking back to your school experiences, can you think of times that would demonstrate your persistence?

• Responsibility:

– Thinking back to times when you were in school or in college, can you tell what role your parents and teachers had in encouraging you to learn new or difficult information?

– Describe the relationship and role your parents had in helping you learn.

– Describe the role your teachers had in helping you learn.

• Structure:

– If you have a rather difficult and complex task to complete, how would you structure your time or plan to complete it?

– Do you prefer to plan out your learning in any particular pattern? Please explain.

• Self:

– Do you prefer to work alone or with others?

• Pairs:

– If you like working with others to learn new information, would you prefer to work with just one other person or with more than one person in a group?
• Peers:

  – Thinking back to your school experiences, did you like working in group situations with people your own age?

  – Did you ever find it helpful to work with people older than you in learning situations?

• Team:

  – How do you operate in team learning situations?

• Adult:

  – In learning situations, do you prefer to learn from those who are older and considered "experts?"

  – In your early learning experiences did you prefer learning from adults?

• Varied:

  – Some people prefer learning from a variety of social situations and interactions. Do you have a preference or can you think of a situation when you preferred learning in a group situation?

• Perceptual:

  – If you were to be given directions to a meeting or party, would you prefer to have them: written down, shown on a map, spoken to you, or given in some other way?
- When in a lecture situation, do you find yourself more attentive to new information that is: shown using pictures/graphs, explained using clear words or phrases, demonstrated with motions/actions.

- When given important information to remember, do you find it helpful to: say it to yourself, write it down in words, make a diagram or picture, or some combination?

- When trying to remember something you have just learned, do you find it helpful to: move around while you try to remember, picture it in your head, recall the words or spoken information, or some other method?

- Which of the following do you prefer the most: movies, music, being active (whole body movement), manipulating objects with your hands (tactile)?

  • Intake:

    - What do you think about having a snack or something to drink while you’re reading a textbook or studying for an exam?

    - Do you munch on snacks or have something to drink when you study?

  • Time:

    - What time of day are you most alert?

    - What time of day do you prefer to work?

    - When in school, did you prefer to do your homework at one particular time of the day more than others?

  • Mobility:
- Do you ever find yourself moving or swinging an arm or leg while studying?
- During a test, do you find it easier to think if you move your pen or tap your fingers?
- When studying for a test, did you ever try walking about the room?

• Global/Analytic:

- When someone is giving a lecture, do you find it easier to follow if you get the main idea first before getting the details? Or do you prefer to get the details first?
- How do you react to a lecturer who begins with a story before getting to the details of a lecture?
- Do you prefer having gained more information and facts or having gained a greater understanding after taking a course or studying something difficult?

• Hemisphericity:

- Do you value details more than major concepts?
- Do you prefer words or pictures to communicate ideas?
- Do you often like to do tasks in a step by step fashion or in a random fashion?
- When working on a complex job, do you prefer a cluttered workplace or an uncluttered workplace?

• Impulsive:

- Are you often compelled to do something right away?
– Do you find it rather challenging to wait until the instructions are given before starting a task?

* Reflective:

– Do you ever find yourself wanting to think about some task before beginning it?

– Before making a big decision, do you take your time or quickly like to have the decision over and done?

### C.2 Second Set of Interview Questions

* What serves as a motivation for you when you’re studying, or when you’re trying to learn something?

* In high school, (or college) were grades important to you?

* Were grades important to your parents or did they make a big deal about them?

* Was there a sense of competition between you and your twin (insert names)?

* Was there a sense of competition between you and your friends?

* What about the issue of persistence? When you’re given a task or when you start an assignment, can you describe how you go about accomplishing it? Describe how persistent you are.

* What about the issue of responsibility? Do you feel if someone entrusts a task to you, how do you think about issues of responsibility? Can you think of some experiences involving the issue of responsibility and how you carried out tasks?
• Who do you feel most responsible to?

• When given a task, do you prefer to be given a lot of leeway as far as how to complete that task, or is it more preferable to be given specific guidelines?

• When you explain something to someone else, let’s say in a tutoring situation, could explain how you might go about that?

• When trying to teach a concept or idea, do you often start with the overall main idea or with the details?

• In learning situations, is it easier to work by yourself, in small groups, or maybe with one other person? How would you describe your optimal social grouping for learning new or difficult information?

• What about in research situations? Have you had opportunities to work in various social group arrangements?

• What’s important about the person that’s helping you do the research? Is it important that the person helping you is considered an “expert?”

• When beginning some new learning task, do you prefer to finish it right there, if time permits, or do you often leave tasks undone to be finished at a later time?

• Do you like to bring tasks to closure?

• Do you prefer working with major concepts or working with fine details?

• What kind of research have you done or participated in?
• In lecture situations, do you find it easier to have the main idea first before getting to the details or do you prefer to get the details first, and then get to the main picture?

• How would you react if the professor began a lecture by telling a research based story? (A story relating to the topic for the lecture)

• What are your future (research) goals? What do you see yourself doing five years from now?

• Is it important to you that people let you know how you’re doing as you’re working on a task, or learning something new?

• Are you a confident person? Is confidence a motivation for you?

• Have you ever been intimidated by science or by researchers?

• Let’s say you just purchased a new VCR or computer. How would you go about using it and learning about it? (Are you more interested in reading the directions or experimenting first?)

• If you’re going to make a major purchase such as a car or computer system, how would you go about learning about the options and qualities of that item?

• Would what other people say factor into your decision?

• What kind of computer do you have? What sorts of tasks do you use it for?

• When you’re studying or thinking about something theoretical, do you ever find yourself having something to drink or munch on while you’re working?
• Is it easy for you to work or study for long periods of time? Do you break up long tasks with intermittent breaks?

• When studying or working on something (i.e. research setting) what time of day would you prefer to work?

• Do you prefer to be able to set your own hours (to work)?

• Do you keep a regular schedule?

C.3 Third Set of Interview Questions

• Do you prefer having a plan (or schedule) for study or work tasks or do you prefer to be spontaneous?

• Are lists helpful?

• Which is the preferred method of instruction for you? To participate in some demonstration, to have a verbal explanation, to view diagrams or graphics of some idea, or to manipulate something in your hands? (Providing, of course that the concept is presented equally well in each of these formats.)

• How do you feel about lab work? (i.e. science labs)

• What time of day do you feel you’re most mentally alert?

• Do you wake up slowly or quickly in the morning? (Or describe how you wake and start getting tasks accomplished in the morning.)

• When you’re studying or concentrating on something are you ever aware of moving an arm or leg, or manipulating a pen or something in your hand?
• I would like for you to describe an optimal learning experience that you had in college. In other words, a time when you felt you understood something new or difficult very well.

• Do you function well in group learning situations?

• Can you describe a learning experience that was not related to traditional school? (informal learning)

• Have you always had an interest in science (or nature)?

• Let’s talk about your reading interests apart from school and study demands. Describe your reading interests.

• Do you usually read one book at a time, or do you have several books started at one time?

• Do you have any particular hobbies or interests? Are some of these maintained on a regular basis?

• Do you have a web page? (or If you were to create one, what types of items would you put on your web page?)

• Describe a professor from whom you’ve learned a great deal. And tell about their methods of instruction.

• I would now like you to look at a list of phrases, and comment on those phrases that closely match your style of learning. (I will use a list of perceptual modality phrases here.)

• When listening to a lecture, do you often take notes?
• When you read something, such as a text book, do you often take notes?

• When you read something you want to remember, do you ever highlight or underline?

• Do you refer back to notes you’ve taken during a lecture or from a reading?

• Describe how you prepare for tests or quizzes.

• In cases where you missed a lecture, how would you prefer that a fellow student help you with what you missed?

• Do you prefer to complete tasks, especially learning tasks, in a step by step, or more random fashion?

• When working on a complex task, do you prefer a neat work place or does it matter what other materials may be nearby?

• What does your optimal study area look like?

• Do you like to finish a task or assignment once you begin it?

• When you’re first given a task, do you find yourself wanting to start it before all the instructions are given?

• Do you feel like you are/were often compared to your twin regarding academic situations?

• Do you think being a twin has helped you become a better learner? (Explain if being a twin has impacted their learning.)

• Do you ever discuss academic or science issues with your twin?
• Do you ever get tired of people asking you what it’s like to be a twin?

• Were most of your college friends in the same major as you, or were they associated with science interests?
APPENDIX D

LIST OF IMPORTANT TERMS

biophysiological Combination of biological and physiological (functioning) processes operating in an organism

case study A qualitative research approach that investigates a single case or a limited number of individuals from a variety of perspectives, with the goal of accumulating a depth of information rather than a broad survey of information from many individuals

concordant Agreement or matched (congruent) scores, responses, or measurements

concordant emergenic relationship Agreement of scores or measurements of characteristics that are due to the influences of and interactions of one’s genetics and one’s experiences

constructivist Educational philosophy or pedagogy that emphasizes and encourages learners to construct and develop their personal understanding and knowledge of a specific concept
**critical period** Chronological period during which physiological and/or cognitive characteristics and abilities develop that if otherwise delayed or inhibited, would result in subsequent deficiencies or limitations for an organism.

**discordant** Disagreement or unmatched (incongruent) scores, responses, or measurements.

**dizygotic (twins)** Twin siblings that resulted from two separately fertilized ovum, sharing approximately half of their genetic information, also called fraternal twins.

**documents** Artifacts collected during the course of qualitative research that give the researcher a more complete understanding of the topic or individual(s) being investigated.

**electroencephalograph** A graphic pattern or depiction of the electrical activity of the brain of an organism.

**emergeuic** The combined effect of several genes that interact and influence an organism or individual, as used and initially reported by Lykken, 1982.

**emergent themes** Themes or patterns that evolve or proceed from data analysis in qualitative research.

**fraternal (twins)** see "dizygotic twins".

**grounded survey** A series of items, questions, or survey items developed based on previous pilot studies or research that are designed by researchers to facilitate data collection.
**identical (twins)** see "monozygotic twins"

**interactionist** The condition or combined effect of two or more factors, in twin research, usually one’s genetics and one’s experiences or environment

**learning styles** The preferred ways in which one perceives, processes, and organizes new and/or difficult information in learning situations

**member check** Process whereby the researcher verifies or authenticates data with the participants involved in a particular study

**monozygotic (twins)** Twin siblings that result from a single fertilized ovum cell that divides and results in both individuals having identical genetic information

**multiple intelligence** Howard Gardner's theory that there are at least seven scales of intelligence including: Interpersonal, Intrapersonal, Verbal-Language, Logical/Mathematical, Visual/Spatial, Bodily/Kinesthetic, Musical.

**perceptual modality** Includes four ways in which individuals prefer to initially perceive or be exposed to new or difficult information: auditory, visual, tactile, and kinesthetic

**thematize** The categorizing and labeling of patterns that occur in data and the analysis phase of research

**trustworthiness** The establishment of consistent and authentic methods and data that supports credible research findings

**uterine environment** The environment within the uterus prior to birth and during a woman’s pregnancy
vignette A descriptive story or anecdote that is considered useful to understanding the participants in case study research, as well as in other methods of qualitative research

WAIS The Wechsler Adult Intelligence Scale, a scale and instrument designed to assess intelligence in adults
APPENDIX E

GLOBAL AND ANALYTIC PHRASE LIST

This grounded survey was developed and given as part of the interview process. It consists of eighteen statements that Dunn has reported as commonly used by analytic and global processors.

As you read each of the following, respond by placing a letter on the line near the phrase to indicate whether: O = I often use or say this; S = I seldom use of say this; or NA = this phrase does not apply to me, and I cannot judge it. Even numbered phrases are often what analytic processors say; while odd numbered phrases are often what global processors say.

1. Why are we doing this? (Or why has this assignment been given?)
2. Does spelling count? (Or how exactly do you want this done?)
3. Not now! I’ll do it later.
4. Should I use a pen or a pencil?
5. I need a break.
6. Should I skip lines or leave spaces?
7. Don’t touch the piles on my desk.
8. Will this be on the test?
9. Why does this really matter?
10. Can I have more time to work on this?
11. Let’s start this project, and that one too!
12. What comes first? Second?
13. Why can’t I skip around in the book?
14. Why can’t we do one thing at a time?
15. I’ll come back to this later.
16. Please check my work before I submit it.
17. Why do we have to do it now? It will still be here later.
18. What are you looking for (in this task / assignment)?
APPENDIX F

PERCEPTUAL MODALITY GROUNDED SURVEY

Respond “often”, “sometimes”, or “seldom” for each question.

1. Can remember more about a subject through lecture method with information, explanations and discussion.

2. Prefer information to be written on the chalkboard, with the use of visual aids and assigned readings.

3. Like to write things down or to take notes for visual review.

4. Prefer to use posters, models, or actual practice and some activities in class.

5. Require explanations of diagrams, graphs, or visual directions.

6. Enjoy working with my hands or making things.

7. Am skillful with and enjoy developing and making graphs and charts.

8. Can tell if sounds match when presented with pairs of sounds.

9. Remember best by writing things down several times.

10. Can understand and follow directions on maps.
11. Do better at academic subjects by listening to lectures and tapes.

12. Play with coins or keys in pockets.

13. Learn to spell better by repeating the words out loud than by writing the word on papers.

14. Can better understand a news article by reading about it in the paper than by listening to the radio.

15. Chew gum, smoke, or snack during studies.

16. Feel the best way to remember is to picture it in your head.

17. Learn spelling by ”finger spelling” words.

18. Would rather listen to a good lecture or speech than read about the same material in a textbook.

19. Am good at working and solving jigsaw puzzles and mazes.

20. Grip objects in hands during learning period.

21. Prefer listening to the news on the radio rather than reading about it in the newspaper.

22. Obtain information on an interesting subject by reading relevant materials.

23. Feel very comfortable touching others, hugging, handshaking, etc.

24. Follow oral directions better than written ones.
References


Dunn, R. (1993). The learning styles of gifted adolescents in nine culturally diverse nations. *InterEd, 26*(64), 4-6.


Kirby, P. (1979). *Cognitive style, learning style, and transfer skill acquisition*. Columbus, OH: The Ohio State University, National Center for Research in Vocational Education.


Laurence, G. (1979). *People types and tiger stripes*. Gainsville, FL: Center for Applications of Psychological Type.


